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ON CERTAIN PECULIARITIES IN THE FLORA OF THE SANTA BARBARA ISLANDS.

BY J. WALTER FEWKES.

THE study of the distribution of terrestrial life on islands has always been a prolific one in theoretical discussions of the origin of species. Darwin and Wallace both drew from this source most interesting conclusions in regard to their theories, and from it are still derived some of the most suggestive facts bearing on questions of geographical distribution, migration and preservation of genera and species.

This is particularly true of oceanic islands separated from continents by wide expanses of the ocean or of chains of islands connecting continental land-masses. The peculiar assemblage of life in Saint Helena, the Galapagos or the Bermudas contribute most important data to the general discussions of the derivation and modification of faunas and floras in isolated tracts of land in the ocean. It thus happens that the study of islands has always had a profound fascination to the investigator of the variations of life on the earth's surface.

As a general thing the terrestrial life of continental islands resembles that of the neighboring land-masses. The very contiguity would seem to imply a colonization of one from the other, and therefore a resemblance, since the ease with which genera and species can be transported across intervening water is an all

sufficient cause for a similarity. While there is evidence that the basins of the great oceans have always been approximately the same as they are at present, the fringes of the continents, or the platforms upon which continental islands rest, have, from time to time, suffered changes of elevation which, in many instances, have raised the intervening sea bottom above the surface of the water, and thus have brought about a means of communication for the life of continents and neighboring islands. In this case it is not necessary to call in the aid of various means of transportation across intervening bodies of water, straits and sounds, for the commingling of the two floras and faunas. Prehistoric man in his early migrations, no doubt, was profoundly affected by a law of distribution similar to that which influenced animals and plants. Using islands as stepping stones he may thus, before he had the hardihood to attempt the ocean in navigation, have even passed from one continent to another at a time when portions of the shallower ridges of the ocean floor now submerged were elevated above the sea. In this way, for instance, he may have migrated on dry land from northern Europe to Greenland and then to the North American continent, or, in a similar way, across what is now Behring Strait and the Aleutian Islands from Asia into Alaska. The possibilities of inter-communication between lands not separated by the abysses of the ocean for races of man, animals and plants are very great, and can only be read in the light of the great geological changes which have occurred on the margin of continents in which elevation and depression have undoubtedly taken place.

Islands which have become separated from the continents by submergence of the land, or by erosion and a cutting out of an intervening channel, preserve, in a measure, the fauna and flora of the adjacent continents, but they are independently affected in somewhat different ways by the struggle for existence of their inhabitants. New conditions may arise or old ones may persist which may or may not lead to the preservation of organic forms which have been exterminated on the adjoining continent. Intercommunication, however, between the two has always had an influence in neutralizing the changes which might otherwise occur.

It may, on the other hand, happen, when islands preserve uniformly the past conditions of the mainland for a longer time than the continents, that their fauna and flora resemble an older assemblage of life of the land of which they are a part, and with which they were formerly connected.

It is believed that the Santa Barbara islands illustrate this latter statement. Climatic changes have, it is thought, taken place on the mainland which have changed the enviroment[1] to that extent that animals and plants once found there have succumbed and disappeared, while these conditions have remained more constant on the islands, where, as a consequence, the destruction of certain organisms has not been so rapid.

It may be borne in mind, however, that the causes which have led to the restriction of certain plants or animals to circumscribed localities in other parts of the world are not all understood. This restriction or local distribution may be due to general or to local causes, yet the former may at times be called to aid when the latter are insufficient. In New England, for instance, a local distribution of certain plants in limited areas often occurs and no explanation can be discovered for their limitation. It must, therefore, be with diffidence that one finding peculiarities in the flora of certain islands ascribes those characteristics to far-reaching rather than local influences. Especially must one use caution in the study of phenomena in which more facts are necessary. The following paper, however, uses the data given by others, but with this precaution, knowing that such speculations may be overturned by new observations and more extended studies bearing on the pecularities of the flora of the islands.

Of the later geologic phenomena which have been called in to account for the present distribution of animals and plants, the glacial period is one of the most important. Possibly too great influence has been ascribed to it on account of the nearness of this period to the present, which it might be expected to most

[1] In environment are included organic as well as climatic changes. The organic environment makes itself felt in a struggle for existence, which counts for as much as, if not more than, climatic changes.

profoundly affect. Looking back into the past, it is the first climatic change which offers great differences of condition from the present.

One of the consequences of the advance and retreat of the great ice sheet which once covered the northern latitudes of North America, is its influence on the distribution of terrestrial life. It is argued that the advance of this ice sheet must have forced southward hardy animals and plants which, when brought into competition with southern species in a struggle for existence, led, through inheritance, to important modifications in the general aspect or facies of the fauna or flora of any given region. In a somewhat like way a retreat of the ice sheet towards the north may be supposed to have enlarged the area for life, and to have drawn with it those organisms which find colder latitudes more congenial to their lives, and thus opened a way to changes in the character of the life inhabiting the areas vacated by them. The survival of Alpine floras and faunas on mountain tops finds a ready explanation in a distribution brought about primarily by the latter of these causes, viz.: the retreat of the glacial ice sheet to the polar regions, and the resemblance of the conditions of those high altitudes to formerly existing in the valleys.

In a discussion of the causes of the peculiar flora of the Santa Barbara Islands pointed out by Prof. Greene, Prof. LeConte[2] has adduced the aid of the glacial period and ascribed this pecularity to the survival of an old flora on the islands, while that of the neighboring continent has been more or less modified by a struggle with hardy denizens forced into it by glacial conditions. His reasoning on this point seems to me cogent and conclusive in general, but not wholly adequate in the special case of the peculiarities of the flora of the Santa Barbara Islands. It is believed that he is right in the supposition that the present flora of Santa Cruz more closely resembles that which once existed on the contiguous coast than it does the present flora of the same locality. The remoteness of the continental glacier as indicated by its terminal moraine must have been great from the region under discussion, and the possibility of its influence on the equilibrium

[2] *Amer. Journ. Arts and Sciences.* Vol. XXXIV.; pp. 457-461.

of life so far away is small. It may be well to look about in order to discover, if possible, other causes nearer the locality for an explanation of this destruction of continental species and the survival of older characteristic genera on the neighboring islands. I think there are other and possibly more effective causes which have had a profound influence in Southern California in this direction.

When hardy[3] species were driven south by glacial cold, they were certainly more fitted to survive in the cold climate than the denizens of a warmer climate which they encountered, simply because the climate was colder. But when the glacial cold was mitigated the animals and plants of warmer climates were more fitted to survive, and in a struggle for existence would be stronger than the "hardy" or those fitted for glacial cold or comparatively low temperatures. Then their influence would be greatest. As the character of the insular flora was less affected than the main land by the hardy animals, we may also suppose it to be less affected than the main land by the return of the warm climate animals at the restoration of a more genial climate. Consequently, not only glacial cold but subsequent milder temperature have acted in unequal degrees upon the inhabitants of islands and main land. If there was a return of conditions of climate similar to that of the Pliocene, like plants to those of the insular flora might be expected to reappear. But a new influence has made inself powerful in modifying environment. The main land has become more desiccated than it formerly was. From the nature of their position the islands are not as profoundly affected by this influence as the continent. Like a huge Briaræus desiccation has spread itself over the south-west, so that, while its influence is exerted on the insular flora, it is not in as marked a manner as on the main land. So potent is this influence that it cannot be lost sight of, and is even as important as glacial cold. We must not forget, also, the profound influence on climate, and, consequently, on the facies of organic life, which the out-pouring of

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the great lava beds may have had. As glacial cold had its influence, the heat resulting from these out-pourings was not without its effect.

The great arid deserts of our south-west, which extend into California, and make their influence felt even to the coast, have had a most important influence in the determination of the character of the fauna and flora of Southern California. This influence has exerted itself in much the same way as the cold[4] of the glacial epoch. The drying up of great tracts of land necessarily led to a crowding of the denizens of the tract thus desiccated into regions not so greatly affected. The result of an influx of individuals intensifies there a struggle for existence, and leads to extermination of less fortunate or weak genera and species. The regions most distantly removed from the most arid regions would necessarily be least affected by the increased desiccation, and on these out-posts of the continents, the islands, where the environment is least modified by this climatic change, we can look for the survivors of the old faunas and floras. The results arrived at by this *a priori* reasoning are exactly what Mr. Greene finds in the distribution of the plants on the Santa Barbara Islands. From his study of the plants of these islands, more especially Santa Cruz, the following, among other conclusions, are derived:

1. Forty-eight out of two hundred and ninety-six species of plants collected are peculiar to these islands, and twenty-eight are peculiar to Santa Cruz.

2. All the species are distinctly Californian and those species which are now found in small numbers in a straggling condition on the neighboring mainland are very abundant on the island.

3. The genus Lavatara, of which eighteen species are known in the Mediterranean region, and one from Australia, is represented by four species on the island of Santa Cruz. *There is not another known species from the American continent.*

There is also a significant fact which is believed to bear on our discussion, viz.: the distribution of land shells on the islands and the neighboring mainland. Indefatigable collectors of West

[4] Waiving the question of whether the glacial period was or was not one of great cold.

Coast shells have not been able to collect land shells near Santa Barbara, and yet on the neighboring islands many of these mollusks are found, notably, a peculiar species of Helix, which, unfortunately, is rapidly being exterminated by the sheep. The presence of these shells on the island, and their absence on the mainland, I suspect, point the same way as the peculiar distribution of the plants, and seem even as significant of the character of the change in the climatic condition of the environment.

The arguments which have been advanced by others to support the proposition that our arid deserts were once better watered than at present, are not necessary to quote here. That these deserts were not always as dry as at present seems to me proven, and the zoological facts in the distribution of the island life look indeed as if such a desiccation has left its mark on the distribution of genera and species.

In view of the distance of the land of Southern California from the sources of glacial cold,[5] it seems difficult to suppose that the equilibrium of life in this low latitude was much affected by this temperature. There are marks of local glaciers on the flanks of the Santa Inez Mountains, and the observer has not to go far from Santa Barbara to find what may be regarded as their moraines, but traces of a continental glacier are believed not to exist in this low latitude. These local glaciers may have driven hardy forms into the valleys by their advance, but it is hard to suppose that to this cause alone a comprehensive change in the flora or fauna has resulted. Desiccation of the climate, however, is a phenomenon of wide distribution in the south-west, and its influence must have been far reaching and great enough to lead to wide-spread modifications in the facies of faunas and floras.

If we ascribe the preservation of the older or partial Pliocene flora in the Santa Barbara Islands to their still retaining a moist climate from the vicinity of the ocean, it may be asked why the adjoining coast, by its situation, is not also acted upon by the same influence? Why are not these same plants protected there as well as on the island, since the vicinity to the ocean may have

[5] Evidence has been rapidly accumulated that the intensity of the so-called glacial cold was not great.

exerted the same influence? To this it can be answered that in places they are so protected, and Mr. Greene has mentioned instances where these insular forms still exist. These scattered localities are not regarded as points where the island genera have migrated to the mainland and there obtained a footing, but as preserving the same congenial influences which have made it possible for them to survive on the islands. It seems to the author that the theory that the preservation of these scattered remnants of the old life is exactly what would result in places on the shore. They are remnants of a flora once widely distributed throughout California.

These straggling colonies of characteristic insular flora are found, according to Mr. Greene, in isolated patches in San Diego and San Bernardino counties. These are supposed by him to be incipient colonizations on the mainland from the islands. Prof. LeConte, on the other hand, regards these patches as survivors of the Pliocene indigenes which have not followed the fate of their relatives, and the situation of these patches of older life in the southern counties, according to the latter, is "just what we might expect, for the main invasion [of hardy forms resulting from the influx due to the glacial cold] was from the north." There seems no valid objection to considering these survivors as remnants of the flora of a former geologic period sheltered by environment from destruction, but the causes which have led to the modification of their associates may not wholly be due to the influences of the glacial period. The other influence is continental desiccation.

The islands have, no doubt, been affected by the dessication of the continent, but not in the same degree as the mainland. Their fauna has changed, no doubt, since they were connected with the mainland and the mammoth was found on both, but not to the same amount. The sea, with its fogs and local evaporation, has counteracted, in a measure, the drying up, which has been most marked at a distance from the sea.

In conclusion, while accepting in the main the theory that glacial cold has had an influence, I would suggest that the main cause of the peculiar flora of Santa Cruz Island, observed by Mr.

Greene, is the change which has come to Southren California by the desiccation of the land. The islands, less acted upon than the main, from position and the neighborhood of the ocean, have, on that account, preserved a flora possibly like the Pliocene once found on the adjoining continent. As the environment changed on the main-land many of the genera died out, but they still persist where conditions are less modified because offset by local causes.

It does not seem necessary to suppose that the islands are remnants of a new centre of distribution of life, or that it is wholly explanatory of the pecularity of the flora to ascribe the extinction of the same plants which now exist on Santa Cruz to a struggle with hardy varieties forced southward by glacial cold. The drying up of the climate is a potent factor which had a great influence and is sufficient, with other causes, to bring about great changes. As high mountains may be regarded as preserving an Alpine flora left in a congenial position by the retreating glacier, so the Santa Barbara Islands may, in a somewhat different way, present us a life preserved in sheltered points by the drying up of the neighboring sections of the continent which has less strongly affected the islands than the main-land.

But neither of these causes alone is adequate to explain the peculiarities of flora or fauna in any circumscribed locality. There are many influences at work, and causes even which may have their origin far away from the regions which they effect. To analyze this nexus of influences is next to impossible. In a broad way we may say that the present facies of the fauna and flora of any circumscribed locality is primarily the result of environment, and where environment changes organic forms must change, while, when it remains constant, less modification is the result. A marked climatic change such as followed the drying up of a great area of such extent as has taken place in our southwest, leaves its mark on the organisms near and remote from it.

Two questions must be answered positively to make our reasoning logical. Has a desiccation taken place? and is it as great on the islands as on the main? Both of these questions are believed to be capable of definite answers. Desiccation has

taken place, and it has not been as great on the islands as on the adjoining continent. There remains at least one fact to be determined, and for its acceptance additional research is certainly necessary. The flora of the Santa Barbara Islands is said to differ essentially from that which at present exists on the neighboring main-land of California. What is the relation of the present flora of California to that of the Santa Barbara Islands, and what was the flora of the main-land, especially in the Pliocene Age? Has there been an intercolonization of islands and continents since that glacial period? These are questions to be answered, but the most important one of all is, "Are any of the plants of the islands peculiar to them?" The above paper accepts the observations of others that they are. It seeks to point out a cause more potent than any yet suggested, to account for peculiarities of this insular flora if such peculiarities exist.

THE TEETH AS EVIDENCE OF EVOLUTION.

W. C. CAHALL.

IN the August number of *Lippincott's Magazine* appeared a paper by W. G. A. Bonwill, entitled "Why I Deny Evolution." The argument is based upon the structure of the teeth and their relation to the human jaw.

It would be as incomplete to confine your argument in support of the law of gravitation to a single phenomenon, *e. g.*, shooting stars, as to rest your plea for evolution upon the human jaw. It is manifestly unjust to the proper appreciation of a great doctrine like Evolution to deliberately deny oneself the great wealth of evidence furnished by Geology, Embryology, Rudimentary Organs, and the Comparative Anatomy of the several organs of the animal economy; yet it would be equally unfair to Dr. Bonwill to meet his argument upon any other ground than that upon which his argument is based, the human jaw.

At the same time the law of gravity, if a true one, ought to explain the phenomena of shooting stars, although it might fail to convey a proper conception of its grandeur and universality; so should evolution afford a full explanation of the complexity and adaptability of the teeth and jaw, and this I firmly believe can be readily done.

Before we proceed with a presentation of the other side of the question, it might be well to offer a few good-natured criticisms of Dr. Bonwill's definitions and claims.

I take issue with his very first sentence, "It must be creation or evolution—creation by some personality placing a perfect organic being at one master-stroke into life and action; or by some impersonality, from the lowest point of life, by slow development reaching higher and higher in the scale of being until man has been reached."

I deny that such a view of evolution is the only one which can be entertained. That the evolution of life upon this planet was the outcome of an impersonal nature, acting by forces strictly physical and without a directing mind, is the belief held by the materialistic school exclusively. To classify all evolutionists as materialists would do the greatest injustice to many of the most eminent scientists in this country and Europe. These men see nothing inconsistent in the belief in evolution as a method by which a personal Creator accomplished his ends, and the account of Moses.

The late Dr. Asa Gray, of Cambridge, accepted as authority throughout the whole scientific world to a degree perhaps never attained by any other American, voices this school when he says: "I am scientifically—and in my own fashion—a Darwinian; philosophically, a convinced theist; and religiously, an acceptor of the creed 'commonly called the Nicene,' as the exponent of the Christian faith."

So when Dr. Bonwill declares: "It must be creation or evolution," he could more correctly have written: "It must be creation *by* evolution." This is theistic evolution.

I also take exception to the loose and unscientific manner with which Dr. Bonwill uses "organs" and "organisms" as words of

synonymous or identical meaning. Nothing is farther from the truth. These words have as distinctive and individual a meaning as any words in scientific usage, conveying totally different ideas. An *organ* is a part of a body capable of performing some especial work, while an *organism* is the whole body, a unit or entity, which the various organs in their mutual relationship compose. That this is not my definition, devised for a purpose, the nearest scientific dictionary will confirm. Ordinarily the misuse of scientific language might result from an oversight and be of little or no importance, but here it is not so, for Dr. Bonwill's leading argument stands or falls with this definition. We will assume that the question which he quotes from Mr. Darwin to be correct: "*Demonstrate* to me a complex organism that can be made in any other way than as I say, by slow, slight modifications, and my argument falls to the ground." To this query of Darwin's he replies: "I have duplicated by design and intelligence the most complex organ in the human body, and made it perform the same function as the natural organ." The organ he refers to here is a set of teeth. There is no evidence here but of entire satisfaction that when he has made a set of teeth, or a "complex organ" as he calls it, he has met the demand of Darwin for a "complex organism." If the words "organ" and "organism" are not identical in meaning to Dr. Bonwill's mind, why does he upon the same page as the above use such language as this: "I claim to have made a demonstration of the construction of a complex organism—the human teeth—according to these laws; a demonstration which accounts for all the functions of the natural organism." "I claim that if I am able to form such a complex organism by a single act of creation, I must be greater than nature, or must have anticipated her by millions of years." "I claim that this organism could not have been made from that in any other existing type of animal or combination of animals." Dr. Bonwill promises to put in book form these arguments. It will be well, before he fulfils this promise, that he should learn that a *complex organism* is something more than an artificial set of teeth.

He claims, and he puts it in italics, "*I claim to have discovered that the lower jaw of man is an equilateral triangle, and that all races have it, and that it has so existed from the advent of the first man.*" Also, "that it belongs exclusively to man." He claims that as an equilateral triangle in a hexagon is the equal of a circle, and as a circle is the embodiment of perfection of form, it is a natural deduction that the human jaw cannot be evolved higher or a more perfect form conceived. Such is the discovery which he has made and which he classes with the law of gravitation, a claim, to say the least, which cannot be characterized as modest.

I will give his own words: "I claim that as Newton discovered that geometry and mechanics governed the formation and action of the astronomical worlds, I have an equal right to the discovery of the relation of the same laws to the structural organic world."

If the human jaw be the perfect instrument claimed for it, and beyond the reach of further evolution, this would not, as he holds, prevent the contrary hypothesis; that it is the end towards which nature has tended by evolution through successive forms of life, from the simpler to the more complex.

That the human jaw is an equilateral triangle is an interesting anatomical observation, and Dr. Bonwill, if he is the first to notice it, should have all credit for discovering the fact; and that the teeth are perfect in position and adaptibility to their intended purpose, goes without saying. But to stop to even enumerate all the observations bearing upon the relation of the various organs to the principles of geometry and mechanics would tire the reader, and the evolutionist of all people would be the last to deny the perfect adaptability of the organs to their destined use, for it is this they bring in evidence as to the truth of evolution.

The intimate relation of the eye to optics, of the ear to acoustics, of the lungs to pneumatics, of the heart to hydraulics, of the digestive organs to chemistry, and the attachments of muscles to bones to the physics of levers, are familiar to every student of anatomy and physiology.

To discover that the human jaw and teeth are so perfect an instrument that human ingenuity cannot conceive of any improvement, but must crudely imitate the pattern nature furnishes when artificial assistance is needed, is no exception; is it not the same with the human eye, the ear, the hand, the foot? A manufacturer of artificial legs might with equal justice claim that he has discovered that the line of junction of the human foot to the leg was a right angle; that all races have it, and that it has so existed from the advent of the first man; that it belongs exclusively to man; that a right angle is the quarter of a perfect circle, and the only angle which will equally divide both a circle and a half circle; that consequently the human foot was a special creation, and could not have been evolved from something lower, and could not have been evolved into something higher; that he had made an artificial leg, which performed all the functions of the natural one, even to the complex movements of the ankle-joint, so perfectly as to deceive all beholders; that—*ad infinitum et ad* ——

Is it not already evident that such a line of reasoning may lead one to the most absurd conclusions?

There is one other question which has no direct bearing upon the argument from the teeth, but which I notice because Dr. Bonwill makes so much of it. He claims that since according to the first law of motion a body once set in motion will continue to move in a straight line forever unless deflected by surrounding bodies, and made to describe an orbit; and as no world ever did go in a straight line, but began at once to move in a circle or ellipse, "it is plain that it never began the universe by making one world at a time and throwing it into space, it being absolutely necessary that there should be at least three worlds in order to counterbalance each other, and make the first law of motion a fact."

There are some arguments which, like a two-edged sword, cut both ways. If such a condition of things be true, I would like an explanation of the first chapter of Genesis, which both Dr. Bonwill and I believe, where we are told that the Lord created the earth, gave it globular form, made dry land appear, and vegetation grow, for *three days before* the sun, moon and stars werecalled forth.

He further says, " I claim that as all organic life has such a struggle for existence, and as nature has to be always on the alert to select, that it is as much as an organ or an organism can do to keep itself up to the standard of healthy action; that *death to the weakest* is rather the rule than " survival of the fittest."

Has not the Doctor here given away his whole case? What is the " survival of the fittest," if it is not by the *death of the weakest.*

Evolution as a process of nature is not the hasty generalization of a single science; rather a greater part of all the sciences have become but widely different yet converging avenues of approach, along which the student travels naturally to the central hypothesis, which has now become the dominant factor in all scientific investigations. It lies at the foundation of the new astronomy of the sidereal and solar systems; geological study of the strata furnishes indubitable evidence of the appearance upon the earth of forms of life of the simplest nature, succeeded by forms of constantly-increasing complexity; comparative anatomy teaches how from the three elementary layers of the blastodermal cells every tissue and organ of every animal is developed along identical lines; comparative botany tells the story; embryology, under the microscope, is daily showing that every highly-organized being is passing through that identical evolution of structure from the simple to the complex which the special creationists deny to nature at large; rudimentary organs are so many interrogation marks, unanswerable on any other ground than that of evolution; sociology is carrying the question into the study of government of the human kind collectively; and the first chapter of Genesis, when read in the light of the evolution hypothesis, reveals a sublimity of conception and accuracy of description never before realized. Testimonies so different, yet confirming each other, appeal with a force like the result of an algebraic problem, which, when tested and confirmed by several different methods, possess an accumulative proof of geometrical rather than numerical ratio. But in our present view of the question the accumulative evidence is lost, for we are confined to a single line of inquiry.

The order of the Vertebrates, as classified by zoologists, accord with the order of succession as found by geology, and are divided into five great sub-divisions, viz: Fishes, Amphibians, Reptiles, Birds, and Mammals.

Only in the vertebrates do we find calcified teeth. In the fishes, some of the lower orders have teeth only partially calcified; which, in fact, appear simply as horny excrescences upon the mucous covering of the mouth. Even teeth such as these did not, like Minerva from the brow of Jove, spring into being, full-formed. If it were found that the teeth, or any other organ, appeared fully-formed, and suddenly, serious objections might then be made against evolution. Nature takes no leaps, but everywhere, in everything, takes some tissue, already existing, and by slight modifications transforms it into some complex organ. So we find that even the simple teeth of the fishes can be traced back to simpler structures in the Invertebrates. Upon the approximating folds of the radiate-shaped mouth of the sea-stars are hardened papillæ and spicules which function as *masticating organs.*

Coming higher in the scale we find the mouths of the Crustacea provided with a firm chitinous framework, with ridges, spicules or setæ forming tooth-like processes opposite each other and moved by muscles. These serve as an efficient apparatus for the comminution of food and are called the *masticatory stomach*.

Among the Mollusca, the mouths of several varieties are provided with jaws, covered with a cuticular membrane, on which are small teeth or hooks directed backward. When this membrane is protruded these teeth are erected, and when drawn back they come together like pincers and hold the prey.

The comparative anatomy and gradation of teeth may be seen by the table on page 232.

Evidence from Paleontology.—The diversity of size, structure and specialized function of the teeth of the Mammalian family are directly traceable to the mode of obtaining food.

The constant use of one variety of food has so developed one portion of the teeth, and atrophied, through disuse, the other portion, that the mouths of the existing families of the Mammalia

present teeth of quite contrasting appearance. Yet the ancestors of the animals whose teeth now so clearly separate them into the piscivorous, carnivorous, insectivorous, herbivorous and omnivorous families, did not so widely diverge. The early Tertiary mammals, whether they were herbivorous or carnivorous, possessed the full number of forty-four teeth, which appears to have been the typical number. While the present adult cud-chewing animals no longer possess the incisors and canines in the upper jaw, those ancient ruminating mammals, the Dicobune, Dichodon, and Anoplotherium, had incisors and canines in both upper and lower jaws.

The elephant has the incisors of the lower jaw absent, the premolars absent, the true molars united into compound organs of great complexity, and the upper incisors developed into tusks, while its great prototype, the Dinotherium, possessed permanent premolars in both jaws, the true molars simple, and had the incisors in the lower jaw. Another example is found in the bear of the present, which has the third true molar absent, while its ancestor, the Amphycyon, has the entire set intact.

Evidence from Embryology and Rudimentary Organs.—Prof. Goodsir has discovered that in the embryos of the modern ruminating mammals, calves, for instance, the rudiments of the canines and of the incisors of the upper jaw appear, but do not pass beyond the rudimentary stage after birth.

An organ which is not in use atrophies, and an animal which has no use for certain teeth loses them. Nature conserves, but wastes not.

The organs may be preserved in the embryos, because the embryo passes through all the stages through which the species passed in its evolution.

In the whalebone whales there are varieties which have the full set of teeth germs to form during fætal life, and even to calcify, but become completely absorbed before birth; in others, where some of the teeth remain in the jaw, they are covered up by the gum during the entire life of the animal; in others still, the teeth of the upper jaw alone are rudimentary and functionless, being imbedded in the gum.

FISHES.	AMPHIBIANS.	REPTILES.	BIRDS.	MAMMALS.
1. Teeth grading from erect horny spicules up to calcareous.	1. Teeth usually calcareous.	1. Teeth always calcareous.		1. Teeth always calcareous.
2. Teeth arranged in rows, two or three in number, and are situate not only upon the jaws, but also, in the ganoids for instance, upon the palatines, vomer, parasphenoid, and onhyoid and branchial arches.	2. Teeth also found upon palatine and vomer, but rarely on the parasphenoid.	2. Among Reptilia, the Ophidia and Sauria alone have teeth on the palatine and pterygoid, while the Crocodilia have teeth only upon the maxillary bone.	2. The Birds have no teeth, but since there are fossil forms which possess them, and since the embryoes of some present birds show teeth in rudimentary form, it is evident that the teeth have been lost to those now extant simply through non-use.	2. The teeth of Mammals are confined to maxillary bones.
3. In some fishes the teeth are fixed in the buccal membrane without support by underlying cartilage and bone, and partly movable; in others, when united to the bone, it is usually through ossification of the bone to the tooth, very rarely a process of bone projects into the tooth.	3. The rule among the Amphibia is for the teeth to be fused (anchylosed) to the bone.	3. The teeth are independently formed. In some of the lower forms (the pleurodont Lizard) the teeth are attached to the side of the jaw; in others, the acrodont Lizards and Crocodilini, they are embedded in the alveoli.		3. The teeth are *entirely* fixed in the alveoli.

4. Teeth are in great numbers; in single, double, or triple series, and are constantly being shed and renewed throughout life. In the shark's mouth may be seen a row of teeth, when broken or worn away, replaced by a second row either just in front or behind the first, which in turn is replaced by the third, and so on indefinitely.	4. In the Amphibia and Reptilia there is a prodigal renewal of the teeth, though not to the extent which obtains in the fishes.		4. Mammals have but two sets of teeth, the milk and the permanent set.
5. Since the teeth of fishes are for seizing of prey and not for masticating it, their usual form is conical and inclined backward.	5. For the same reason the teeth of Amphibia and Reptilia are likewise conical and bent backward. There is one exception in the Lizard family, where the teeth are differentiated and thus approach the classification common among the mammalia.		5. The teeth, with few exceptions, are differentiated into the incisors, canine and molars, one or the other of these predominating as the mammal's habit of feeding has modified them.
6. The lower jaw is of cartilage and attached to the skull by a loose cartilaginous ligament, which allows only an up and down motion.	6. Among the Amphibia and Reptilia the lower jaw (sometimes bony and sometimes partly cartilaginous) is attached to the skull loosely through an intermediate bone, the tympanic bone, which allows an extraordinary separation of the jaws, as in snakes when swallowing their prey, but which precludes the chewing of food and which allows only the simple vertical motion of the jaw.		6. The lower jaw of all mammals articulates directly to the skull, but there is great diversity of motion of the jaw in the Mammalia. In those of carnivorous habit, whose food and mode of eating are similar to the fish and reptiles, there is the simple hinged motion in a vertical plane; in the herbivorous animals, whose food requires to be ground before swallowing, have developed a lateral, sliding motion of the molars one upon the other; while in the omnivorous, both of these motions are preserved.

In the embryos of some birds the rudiments of teeth are distinctly traceable, yet in no class of birds extant do the teeth pass beyond this rudimentary stage. How can these rudimentary organs be explained by believers in special creations? Surely not, as is usually explained, "in order to complete the scheme of nature" or "for the sake of symmetry," for if these be the reasons, why do not the rudimentary teeth appear in the embryos of all birds, of turtles, and of some ant-eaters, where they are not present at any age? On the other hand, how clear the question becomes in the light of evolution by natural selection! As Darwin has so aptly put it; "The unity of type is explained by unity of descent."

Nor can rudimentary organs be explained by assuming them of some use to the animals. On the contrary there are some of positive harm to the possessor. Confined to the teeth as we are by the present discussion, we can still find an instance here, and in no less an animal than man himself. There are in the upper jaw two small premaxillary bones which in the lower animals remain distinct and separate throughout life, but in man early become fused with the larger maxillary bones. It is from this premaxillary bone that the upper incisors spring. Now in a certain proportion of cases these premaxillary bones do not become united in man, but remain separated. This is the condition in that repulsive malformation known as hare-lip, from its resemblance to the condition found normally in the hare family. Now does it not seem reasonable to suppose that, if man were a special creation, he would have been created without a premaxillary bone? In view of this defect, while man does possess a marvelously complete apparatus, it is thus far not a *perfect* mouth.

Dr. Bonwill makes the claim that, since the jaw of man is an equilateral triangle, it is the most perfect of mouths. The perfection here must be comparative rather than absolute. It is no more perfect in its way than the jaw and teeth of the serpent, the well developed canines of the Carnivora, and the grinding molars and lateral motion of the jaw of the Herbivora, are in their way. Each is no more perfect for its use than the others

are for theirs. But even within the question of the perfect angle of the human jaw there is something suggestive of evolution, for among the mammals there is every gradation from the long jaw with its acute anterior angle and narrow base to the ampler anterior angle and broader base of the human jaw. There is a constant shortening and recession of the jaw as we approach man, and even in the races of man himself, we see the same gradation, for in the inferior races, such as the Negro and Australian, the lower jaw protrudes farther than does that of the superior races. But even the perfect, equilateral triangular jaw of modern man is being transformed into something different by civilization.

Darwin in the "Descent of Man" remarked that "it appears as if the posterior molar or wisdom-teeth were tending to become rudimentary in the more civilized races of man."

From a careful study of 1,249 skulls, of which 844 were of the highly civilized modern races, 277 of modern inferior races, and 128 were of the Romans, Etruscans, Phœnicians, and other nations of antiquity, Prof. Mantegazza furnishes corroborative evidence of this tendency, for he finds that the wisdom teeth are more frequently absent in the superior than in the inferior types, the percentage of absence being more than twice as great in the former as in the latter. He concludes that at a period more or less remote the third molar will disappear from the human jaw.

It has been also observed that the third molar or wisdom tooth is smaller than the other molars in man, and the same has been found true of the chimpanzee and orang, the apes which most closely approximate man.

In the superior races of man the wisdom teeth frequently remain imperfectly developed beneath the gum, and when they emerge early decay, and they have only two separate fangs, while in some inferior (Melanian) races these teeth are usually sound, and generally have three fangs, thus more nearly approaching the typical mammalian third molar.

This loss of size of the wisdom teeth is due, according to Prof. Schaaffhausen, "to the posterior portion of the jaw being always shortened in the more civilized because they use soft cooked food, and use their jaws less."

So the great law of the equilateral triangle, which Dr. Bonwill has discovered, and ranks beside the immutable law of gravitation, and which he believes impossible save by a special creation, bids fair to be undone by man himself, and to be superseded through civilization by a jaw of greater anterior angle and of broader base.

INSTANCES OF THE EFFECT OF MUSICAL SOUNDS ON ANIMALS.

BY R. E. C. STEARNS.

(Continued from page 130.)

ANOTHER anecdote relating to

PIGEONS AND MUSIC

is recorded by Goodrich.

"Bertoni, a famous instructor in music, while residing in Venice, took a pigeon for his companion, and, being very fond of birds, made a great pet of it. The pigeon, by being constantly in its master's company, obtained so perfect an ear for music that no one who saw his behavior could doubt for a moment the pleasure it took in hearing its master play and sing."

The Rev. Mr. James also furnished us with the following:

"I have a canary of the feminine persuasion who is particularly fond of music. Immediately I begin to play upon the flute she chirps about as if enjoying the music. If I open the cage-door and leave her, she will come as near to me as possible, but not attempt to fly to the music; but if I put her upon my desk, and lay the flute down, she will perch upon the end, and allow me to raise the instrument and play. I often take her into the church and play there upon the organ, and she will perch upon my fingers, notwithstanding the inconvenience of the motion of the hands, and chirp in evident delight at the sweet sounds."

Following in the train of the domestic animals the hare furnishes an intermediate link between the same and the true *feræ naturæ*.

HARES AND MUSIC.

One Sunday evening five choristers were walking on the banks of the river Mersey, in England. Being somewhat tired, they sat down and began to sing an anthem. The field where they sat had a wood at its termination. While they were singing a hare issued from this wood, came with rapidity toward the place where they were sitting, and made a dead stand in the open field. She seemed to enjoy the harmony of the music, and turned her head frequently, as if listening. When they stopped she turned slowly toward the wood. When she had nearly reached the end of the field they again commenced an anthem, at which the hare turned around and ran swiftly back to within the same distance as before, where she listened with apparent rapture till they had finished. She then bent her way toward the forest with a slow pace, and disappeared."

SEALS AND MUSIC.

Mr. Laing, in his account of a voyage to Spitzbergen, mentions that the son of the master of the vessel in which he sailed, who was fond of playing on the violin, never failed to have a numerous auditory when in the seas frequented by seals, and they have been seen to follow a ship for miles when any person was playing on deck.

HYENAS AND MUSIC.

Sparman furnishes the following story: "One night at a feast near the Cape a trumpeter who had got himself well filled with liquor, was carried out of doors in order to cool and sober him. The scent of him soon attracted a spotted hyena, which threw him on his back and carried him away to Sable Mountain, thinking him a corpse and consequently a fair prize. In the meantime our drunken musician awoke, sufficiently sensible to know the danger of his situation and to sound his alarm with his

trumpet, which he carried at his side. The beast, as it may be imagined, was greatly frightened in its turn, and immediately ran away."

THE WOLF AND THE PIPER.

A story is told of a Scotch bagpiper, who was traveling in Ireland one evening, when he suddenly encountered a wolf that seemed to be very ravenous. The poor man could think of no other expedient to save his life than to open his wallet and try the effect of hospitality. He did so, and the savage beast swallowed all that was thrown to him with such voracity that it seemed as if his appetite was not in the least degree satisfied. The whole stock of provisions was, of course, soon spent, and now the man's only resource was in the virtues of his bagpipe. This the monster no sooner heard then he took to the mountains with the same precipitation with which he had left them. The poor piper did not wholly enjoy his deliverance, for, looking ruefully at his empty wallet, he shook his fist at the departing animal, saying, "Ay! are these your tricks? Had I known your humor, you should have had your music before your supper."

The flight of the wolf before "the virtues" of a bagpipe may be interpreted as evidence of highly æsthetic sound sense in the said animal.

HIPPOPOTAMI AND MUSIC.

The enterprising and lamented Clapperton informs us that, when he was departing on a warlike expedition from Lake Muggaby, he had convincing proofs that the hippopotami are sensibly affected by musical sound:

"As the expedition passed along the banks of the lake at sunrise," says he, "these uncouth and stupendous animals followed the drums the whole length of the water, sometimes approaching so close to the shore that the spray they spouted from their mouths reached the persons who were passing along the banks. I counted fifteen, at one time, sporting on the surface of the water."

ALLIGATOR AND MUSIC.

"When the late Dr. Stimpson and I were in Florida in 1869, some person gave him a young alligator. The specimen was about two-and-a-half feet from tip of snout to tip of tail. To secure the beast we made a halter of a piece of bedcord, say three feet long, tying one end around its neck and the other to the leg of the table in the room we slept in. While sitting before a pitch-pine fire in the evening, discussing the events of the day, by way of variety we serenaded that alligator with vocal performances of a high order. Our musical efforts produced, so far as we could perceive, not the slightest effect; the poor brute knew that he was tied, and that it would be useless to try and get away"

From the gigantic and uncouth let us return to the more attractive and familiar animals belonging to certain groups of the Rodentia, some of which are almost domestic through the proximity of their habitat to that of man.

SQUIRRELS AND MUSIC.

In Dr. Merriam's charming volume, in treating of the gray squirrels,[1] he says: "They were extremely fond of music (in the mort comprehensive sense of the term), and it affected them in a peculiar manner. Some were not only fascinated but actually spellbound by the music-box or guitar. And one particularly weak-minded individual was so unrefined in his taste that, if I advanced slowly, whistling "Just before the Battle, Mother," in as pathetic tones as I could muster for the occasion, he would permit me even to stroke his back, sometimes expressing his pleasure by making a low purring sound. This was a gray, and I several times approached and stroked him as above desceibed. I once succeeded in getting near enough to a black to touch him, whereupon he instantly came to his senses and fled. When listening to music they all acted much in the same way. They always sat bolt upright, inclining a little forward (and if eating a nut were sure to

[1] *Sciurus carolinensis leucotis.*

drop it), letting the forepaws hang listlessly over the breast, and, turning the head to one side in a bewildered sort of way, assumed a most idiotic expression.

MICE AND MUSIC.

In 1804 Dr. Samuel Cramer, of Virginia, communicated to Dr. Barton the following very curious account of the influence of music upon the common House Mouse. He said: "One evening in the month of December, as a few officers on a British man-of-war in the harbor of Portsmouth were seated around the fire, one of them began to play a plaintive air on the violin. He had scarcely performed ten minutes when a mouse, apparently frantic, made its appearance in the centre of the floor, near the large table which usually stands in the ward-room,—the residence of the lieutenants in ships of the line. The strange gestures of the little animal strongly excited the attention of the officers, who, with one consent, resolved to suffer it to continue its singular actions unmolested. Its exertions now appeared to be greater every moment. It shook its head, leaped about the table, and exhibited signs of the most ecstatic delight.

"It was observed that in proportion to the gradation of the tones of the soft point the ecstacy of the animal appeared to be increased, and *vice versa*. After performing actions which an animal so diminutive would at first sight seem incapable of, the little creature, to the astonishment of the delighted spectators, suddenly ceased to move; fell down and expired without evincing any symptoms of pain." [2]

The anecdotes herein submitted are more entertaining than important; they contribute but little to our enlightenment on the main point. As a totality they are sufficient to show that an interesting field of inquiry is offered to us, that experiments are worth the making, and that only by carefully devised experiments can satisfactory data be obtained.

[2] The *Phila. Med. and Phys. Jour.*, Vol. 1, 1804, as quoted by Dr. Merriam in his "Mammals, etc."

In reviewing the examples here brought together, those whcih relate to the effect of flute notes on sheep and pigeons are usefully suggestive, as furnishing a hint; *first*, as to an instrument, and *second*, indicating a class of sounds worth experimenting with.

The interest exhibited by pigs, oxen, and cows in the more complex musical sounds, or combinations of sounds, such as would be classed under the second definition, is shown by some of the examples. We have no information as to the character of the instruments, or the tunes, or sounds. The simple fact is proven that these animals were attracted by instrumental music, and the inference is that the sensations produced were pleasurable.

As to how far the behavior of the dogs in some of the cases given may be attributed to or regarded as the effect of music, or considered as nothing more than a manifestation of impulse or spontaneous activity which takes a hand in whatever is going on at the time; it is evident that this is a question for future determination.

We have all noticed the pleasure exhibited by these animals when the master puts on his hat and goes out for a walk, a drive, or a hunt. We have seen them racing with each other, with horses in the field, when both horses and dogs seem to derive pleasure from the performance, and to be acting under the impulse which finds birth in exuberant vitality, or simple, healthful life. It would seem that the example of motion excites to action, and the sight of a swiftly moving railway train or a locomotive tempts and stimulates them to trials of speed.

In the Lake Superior region, where I lived thirty years ago, in the winter season, which meant, at that time, five months' isolation from the rest of mankind, the mail-bags were carried once a fortnight by dog-trains in charge of three or four Indians or half-breeds. There were generally three or four sleds, with as many dogs to each. The dogs were gaily decorated with bits of bright-colored flannel and ribbons, and bells were added for sound and show. Upon arriving at the summit of a hill about half a mile from the centre of the camp, they halted for a breathing spell. I shall never forget the lively scenes that always followed these brief halts, when men and dogs started down the

slope towards my office, at full speed; the Indians whooping at the top of their voices, and the dogs adding to the tumult by their vociferous and joyful barking, and the merry jingle of the bells.

Here man and beast were moved by a common impulse, which found relief, expression, and pleasure in intense activity and noise. They had shared together, as companions and friends, the fatigue and dangers and monotony of a long journey over dreary reaches and wastes of snow, and through the gloom of silent forests, and now had reached the end which gave them rest, food, and security.

It is hardly worth the time to further consider the illustrations here brought together, as they are for the greater part not sufficiently circumstantial to furnish a deduction of any real value; they are rather like straws in the air which indicate the course of the wind, or blaze-marks on the trees that indicate a path to be followed.

REFERENCES:

The paragraphs beginning page 26, line 16; p. 127, l. 23; p. 128, l. 8; p. 236, l. 9; p. 237, l. 4, 19, 26; p. 238, l. 4, 23; are taken from Goodrich's little book, "Anecdotes of the Animal Kingdom," 16 mo., Boston: 1848. P. 26, l. 23, 28; p. 123, l. 1, 19; p. 124. l. 29; p. 125, l. 18, 27; p. 126, l. 10, 29; from *Science Gossip*, various years to 1875, P. 27, l. 6; p. 28, l. 4; letter from Rev. Mr. James, March 24, 1884. P. 27, l. 17; letter from Prof. Davidson, March 22, 1885. P. 28, l. 18; correspondence of *Globe-Democrat*. P. 239, l. 17; from "The Mammals of the Adirondack Region," by C. Hart Merriam, M.D., N. Y.: 1884. Published by the Author.

GENESIS OF THE ACTINOCRINIDÆ.

BY CHARLES R. KEYES.

THE crinoids belonging to the family Actinocrinidæ reached their greatest development and expansion during the lower Carboniferous period. In the American rocks the variety and number of these forms is indeed remarkable, perhaps nowhere equaled in any other age or region.

As regards the distribution of the group in time and space, and the phylogenetic history of the camarate forms in general, many pregnant suggestions have recently been offered by certain terranes in the Mississippi valley. But until quite lately attention has been turned in other directions than towards the solving of these problems; to the purely geologic considerations, and to the description of species. That such a large number of specific and higher terms should have been proposed, many of which are now regarded as invalid, is not surprising when it is remembered that serial comparisons were made only in exceptional cases, and that most of the forms show great variation, even now often offering more or less difficulty in definitely limiting the several sections. More recently efforts have been turned towards the structural features of the different groups, with most gratifying results towards a better understanding of the class. For a long time previous the lack of a sufficient variety and quantity of well-preserved examples of the occurring species had greatly embarrassed all efforts of this kind; and in many cases had led to very erroneous conclusions concerning the real structure of various parts of the skeletal arrangement. Late finds, however, have in great measure removed many of the difficulties that earlier would have very much hindered any attempts towards a satisfactory solution of the two questions already alluded to. They have also supplied enough additional data to render profitable the consideration anew of the entire stratigraphy of the Carboniferous rocks of the broad continental interior, with the

manifest result of a much better defined subdivision of the series than that now existing.

Geologic Distribution of the Actinocrinidæ.—More than three-fourths of the total number of genera of Actinocrinidæ are represented in America, distributed in time as shown in the accompanying chart, the relative expansion of each genus being also indicated. As compared with the ages preceding, the lower Carboniferous is here greatly exaggerated in order to show more clearly the relationship of the several zoological groups, for it was during this time that the greatest diversity of form, structure and general ornamentation occurred; in fact it was the culminating period of crinoidal life in America. Continuous lines are drawn where the record is complete and the transitions fully shown, while the dotted lines indicate the relation of the different types according to the evidence at present known, and probably coincide very closely with the real courses of divergence. The scheme is, then, to represent in a graphic way the relationship of the genera as now understood, rather than to construct a genealogical tree, with which attempts of this kind are often confounded. In the present instance some of the earlier, more generalized forms have not as yet been made known. There are also good grounds for believing that some of the generic types are considerably older than actual observation shows. In other groups, more particularly, there is abundant evidence pointing to a much higher antiquity of the leading generic types than is generally supposed. This is especially true of many widely distributed living organisms whose ancestry has lately proved to be very ancient.

Elements of Classification.—The most generalized type of the family Actinocrinidæ has dorsally a single ring of basal plates, three in number and of equal size, succeeded by a second circle of subequal pieces, six in number—the five radial and the primary anal plates. As in all camarate crinoids, the brachials for a considerable distance are incorporated into the calyx by means of interradial ossioles, and in the free portion of the rays they are biserial and closely interlocking. Ventrally five orals can, with a few exceptions, be made out; they are usually sur-

rounded by a greater or less number of smaller pieces. The anal aperture may be a simple opening immediately back of the orals, or at the end of a long ventral tube.

The fundamental modifications in the arrangement of the various plates give trustworthy criteria for the basis of genera; while the ornamentation, relative size and shape of the calyx ossicles form very satisfactory features for the distinction of species. The taxonomic values attached by different paleontologists to the various characters are not the same. This difference of interpretation, however, appears to arise largely from inattention to the ontogenetic history of the living forms of the class. But this diversity of opinion, happily, is rapidly lessening, with the prospect of a speedy agreement, at least in the main features, as to the relative worth of the separate structures in classification.

General Morphological Changes. — Before passing, however, to morphological details, it may be well to call attention to some widely-spread variations recorded. Briefly summing up, then, the statements recently [1] made in a general consideration of the most marked anatomical features displayed by the Carboniferous crinoids of the Mississippi basin, it may be said that these organisms, from the beginning of the lower carboniferous to the close of the Keokuk, showed: (1) a wonderful and extremely varied development of different structural characters; (2) a constant increase in size and massiveness of test; (3) a peculiar change in ornamentation, which, from the delicate style of the earlier forms, gradually grew more and more bold and rugged; and (4) many curious modifications in minor particulars.

These striking and wide-spread phenomena point to very decided changes in surroundings, such as might have resulted from a gradual decrease in the depth of the sea, a slight diminution, in the density of the water and the introduction of fine sediment in consequence of the nearer proximity to the drainage courses of the young continent, or marked alterations in the coastal contour of the neighboring mainland. There probably were acting also numerous other though less apparent influences. Indeed, these suggestions find substantiation in the stratigraphy

[1] Keyes: Carb. Echin. Mississippi Basin, *Am. Jour. Sci.*, Sept., 1889.

of the region, which gives every reason to believe that the changes went on quietly, yet at a rather rapid rate. The great abundance of individuals at this time may be due, in part at least, to the withdrawal of their more motile enemies because of the unsuitable physical impositions already mentioned. The comparatively rapid changes of environment thus imposed would force rapid modifications in the structure of the various individuals in order to secure a more perfect adaptation to the new conditions. And when these physical changes went on with still greater rapidity structural adjustment was unable to keep pace, and soon ended in the extinction of the group. The unfavorable conditions at a somewhat later period are further shown in the neighboring districts where a few types still persisted, small, depauperate and few in numbers.

Generic Considerations.—The Actinocrinoids are first known in the upper Silurian. They early showed signs of departure from the primitive form; and developed chiefly along two divergent lines. The one group continued to the Burlington with but slight tendencies to modification in general structure; the other soon broke up into a number of more or less well-marked sections, each of which rapidly expanded into new generic types, until about the close of the Keokuk, where, with a single exception, they became extinct. The present account will therefore make mention of the following groups as comprising the Actinocrinidæ: Periechocrinus, Megistocrinus, Amphoracrinus, Alloprosallocrinus, Agaricocrinus, Dorycrinus, Gennæocrinus, Eretmocrinus, Batocrinus, Actinocrinus, Teleiocrinus, Physetocrinus, Strotocrinus and Steganocrinus.

The general structure of the forms has already been alluded to, but some minor anatomical points in various genera may require further consideration. The first of the sections above referred to includes only two types—Periechocrinus and Megistocrinus. These genera differ from the other members of the family chiefly in the relatively large calyx, rather small branching arms, the large number of interradial plates, and in the structure of the ventral surface. In Periechocrinus the plates are smooth and thin; in Megistocrinus rather thick and more or less highly or-

amented. The anal interradius has three ossicles in the second tier, with many smaller pieces in the succeeding rows.

Amphoracrinus, in the general construction of the calyx, closely approaches some forms of Agaricocrinus, but its arms are very different, resembling more those of the preceding group. There are also other important distinctions. The earliest Agaricocrinus appears in the Kinderhook. At the beginning of the Keokuk a curious differentiation in some of the forms took place, giving rise to Alloprosallocrinus, of which but a single species is as yet known. The genus first mentioned is characterized by the flattened or concave dorsal region of the calyx, the free arms being given off low down on the margin of the basal plane. The rays are somewhat separated, especially on the posterior side, where a vertical row of anal plates is very noticeable. Ventrally, the calyx is greatly protuberant, and sometimes inflated not unlike that in Amphoracrinus.

Dorycrinus is the direct lineal successor of Gennæocrinus, from which it should, perhaps, not be separated generically. The anal structure links it closely with Agaricocrinus. It differs, however, in having the general arrangement of the calyx more like Batocrinus, and in a less massive arm structure. The long spines, so conspicuous on the ventral plates of some species, seem to be merely greatly exaggerated developments, homologous with the large nodosites on similar plates in Agaricocrinus.

Extreme forms of Eretmocrinus differ from those of Batocrinus principally in the long, lanceolate arms and inflated ventral parts. But the gradations are very complete, and it is often difficult to separate the forms of the two groups. In Batocrinus, the long anal tube, like that of the typical form of the family, is very prominent. The arms are short; the plates in the second tier of the anal interradius three in number, and the orals large and well defined.

Actinocrinus and the genera following have only two pieces in the second anal tier. In the leading genus two rather well-defined sections are recognized: one with the arms equi-distant around the margin of the calyx; the others with the arms in clusters, imparting a strongly quinquelobate symmetry. The

small number of brachials below the free arms is also very noticeable when compared with the four groups yet to be considered. Teleiocrinus departs from the type just mentioned in having a greater number of the lower brachials incorporated into the calyx, and forming a more or less pronounced decagonal rim just above those of the second order. In this respect it approaches somewhat towards Strotocrinus, but the latter has a very different ventral structure. Physetocrinus and Strotocrinus both differ from Actinocrinus in the structure of the ventral side, while the anal opening is a simple aperture in the test. The first of these types has the ventral portions of the calyx greatly elevated; the second nearly flat, while the rim is enormously developed, and the terminal free arms are not given off until the twelfth to fifteenth order of brachials. The calyx of Steganocrinus is most like that of the lobed section of Actinocrinus, but the radial extensions are most remarkable, and give rise to a very large number of free arms.

Geologic Development.—Inasmuch as the different phases passed through during the known existence of several of the genera mentioned have already been referred to elsewhere,[2] it is hardly necessary to take up here each group sepapately. It will suffice simply to consider somewhat in detail the geologic history of one of the leading generic types,—Actinocrinus,—which will also indicate the general course of development pursued by the other members of the family.

As yet the genus Actinocrinus is not known before the earliest part of the Lower Carboniferous—the Kinderhook. The forms from this horizon thus far discovered have all a more or less globular calyx, with the arms equidistantly distributed. The ornamentation has already assumed two very distinct phases. In the one, delicate ridges or small confluent nodes pass from the central portion of each dorsal plate of the calyx to the center of adjoining ossicles; in the other, the ridges are very inconspicuous, and the plates are strongly convex on the outer surface. These two styles of sculpturing continue during the existence of the group; but the first gradually loses its identity, while the second

[2] Wachsmuth and Springer, Proc. Acad. Nat. Sci., Phila., 1878.

becomes greatly intensified. In the earlier species the free arms are slender, growing much stouter in the Burlington and Keokuk, and in the latter often also branching one or more times. This development is accompanied by an increasing massiveness of the calyx plates and a change of the simple convexity of the ossicles into great, rude nodosities. Another marked feature is the tendency for the rays to separate from one another above the second brachials, forming prominent radial extensions before giving off the free arms. At the same time the interradial areas become somewhat more depressed. The quinquelobate calyx is thus produced; the form upon which the genus was was founded. In general it may be said that the earlier forms were of small size, delicately constructed and ornamented, and that they gradually became very much larger and more massive, with a rough, rugged ornamentation.

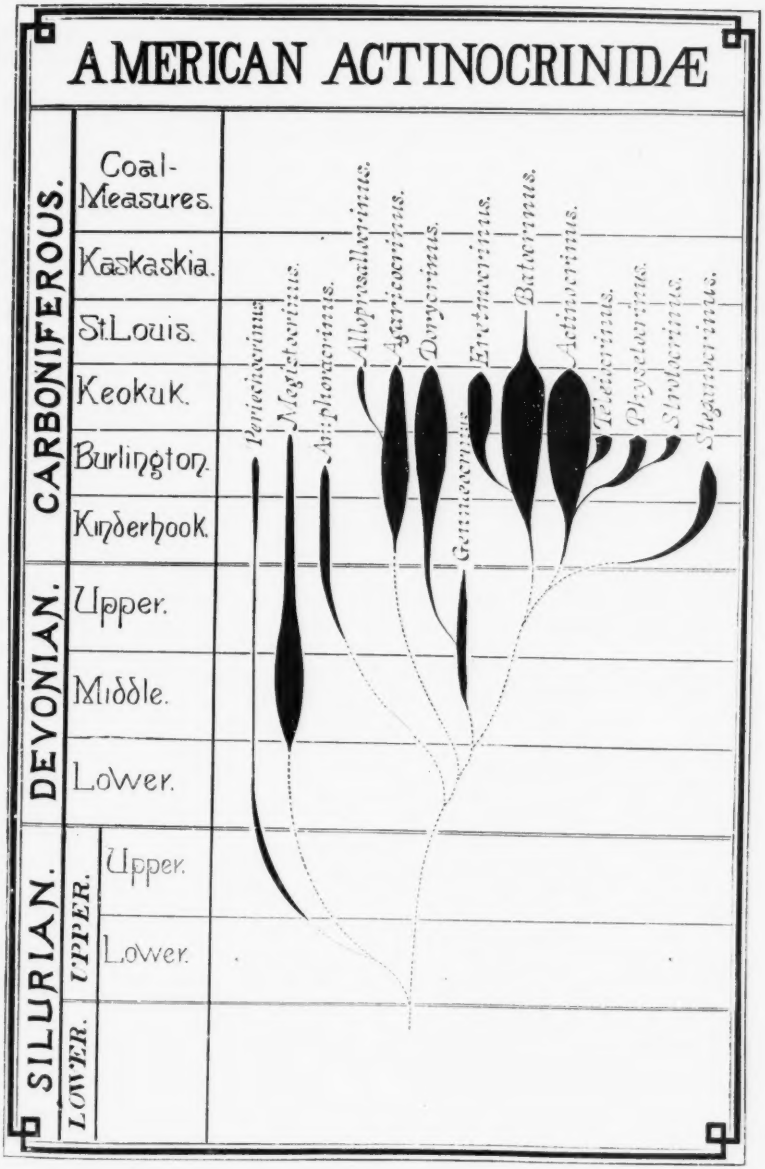
The more striking points in the development of the anatomical features in Actinocrinus, as here briefly traced, apply to the other genera here mentioned, and also to the members of other related families. Besides, Dorycrinus developed huge vertebral spines; Batocrinus, an immense disk-shaped calyx; Eretmocrinust broad lanceolate arms; Strotocrinus, a large rim stretching out laterally from above the tertiary brachials; and Steganocrinus, monstrous radial extensions, from which the free arm sprung.

Generic Relationships.—As previously stated, Periechocrinus and Megistocrinus are closely related, but differ considerably from other members of the family. Their recorded history also extends over a much longer period than that of the other twelve genera. Periechocrinus occurs first in the Niagara,—large, thin plated forms, nearly devoid of ornamentation, and having tall obconic calyces, with long arms branching one or more times. The evidence of this type in the American Devonian is as yet rather meager, though in Europe abundant testimony of its existence in rocks of similar age is not lacking. The forms found in the Lower Carboniferous present a somewhat different aspect from those of the earlier periods, having the calyx very much shortened and proportionately broadened at the base of the free arms, besides differing in several other respects.

On the other hand, Megistocrinus, with its thick, heavy plates, boldly sculptured, and having a very depressed calyx, reached its greatest development in the middle Devonian. It continued, though in greatly lessened numbers, to the upper part of the Burlington, where it became extinct. Both genera appear to have a larger number of dorsal interradials, especially on the anal side, than any other of the Actinocrinoid genera.

Amphoracrinus approaches Agaricocrinus in the flattened dorsal cup, the high, often inflated, ventral portions, and in the shape and arrangement of the plates of the aboral side. The anal side and arms connect it with Actinocrinus and Periechocrinus: with the former by the possession of usually only two ossicles in the second tier, by the absence of the marked vertical row of anal plates, and by the presence of a short sub-central anal tube; with the latter by the peculiar structure of the free arms.

Agaricocrinus is remarkable for the greatly depressed form of the calyx, the dorsal cup being nearly flat, or, as in some of the later species, decidedly concave. Its resemblance to Amphoracrinus has been referred to above. In anal structure it is identical with Dorycrinus, having the same arrangement of plates, and a similar vertical rounded ridge near the top of which is the simple anal opening. The arms are exceedingly stout, somewhat like those in certain forms of Actinocrinus from the lower part of the Burlington limestone, but very much heavier. Agaricocrinus, Amphoracrinus, and Dorycrinus probably began to diverge from the more typical members of the family and from each other about the same time, and this apparently took place during the middle or lower Devonian. In the upper part of the Burlington or early Keokuk a small group of forms departed somewhat from the typical species. These have been placed under Alloprosallocrinus, though it is doubtful whether the differences are great enough to render a separate generic term useful. The chief point of distinction is the position of the anal opening, which is placed at the end of a short ventral tube, instead of being a simple aperture in the test, as in Agaricocrinus. It seems, however, that much more importance has been hitherto


AMERICAN ACTINOCRINIDÆ
SILURIAN.
LOWER.
UPPER.
Upper.
Lower.
DEVONIAN.
Upper.
Middle.
Lower.
CARBONIFEROUS.
Kinderhook.
Burlington.
Keokuk.
St.Louis.
Kaskaskia.
Coal-Measures.
Periechocrinus
Megistocrinus.
Abrotocrinus.
Allopresbycrinus.
Agaricocrinus.
Dorycrinus.
Graphiocrinus.
Eretmocrinus.
Batocrinus.
Actinocrinus.
Teleiocrinus.
Physetocrinus.
Strotocrinus.
Stegnocrinus.

placed upon this structure in classification than it probably deserves, as will be referred to later.

Dorycrinus is directly traceable to a certain group of Devonian crinoids for which the name Gennæocrinus has been proposed. The latter genus embraces a few small forms, mostly from the Hamilton rocks. The species of Gennæocrinus, as for example *G. cassedayi* Lyon, are connected with Burlington and later Dorycrinus by such forms as lately have been found in the Kinderhook beds of Central Iowa, and which have been described by Wachsmuth and Springer as *D. immaturus* and *D. parvibasis*. Dorycrinus, in combining the features of both, unites closely the Batocrinoid and Agaricocrinoid groups. It agrees with the first in the peculiar construction of the posterior side, in the simple anal opening, and in the radial grouping of the arms; with the second in the shape and structure of the calyx, and in the somewhat flattened distal portions of the arms, in this respect approaching certain Eretmocrini. In the earlier, more generalized forms the close resemblance of Dorycrinus, Agaricocrinus and Eretmocrinus or Batocrinus is far more striking than with later varieties which have become so greatly differentiated. The most prominent features, perhaps, to be noted in this connection are the monstrous ventral spines, often reaching a length of three to five inches, as in *D. mississippiensis* Roemer, and *D. roemeri* M. and W.; the immense basal expansion, as shown by *D. missouriensis* (Shumard) and *D. cornigerus* (Hall); and the stout, heavy stalks with large, conspicuous nodal joints.

Eretmocrinus differs from its nearest related genus—Batocrinus—of which it is manifestly an offshoot, chiefly in having long, flattened, lanceolate arms, a somewhat different ventral structure, and usually a more or less well defined lateral extension of the basals. The genus was rather short-lived, appearing in the Burlington and becoming extinct before the close of the Keokuk.

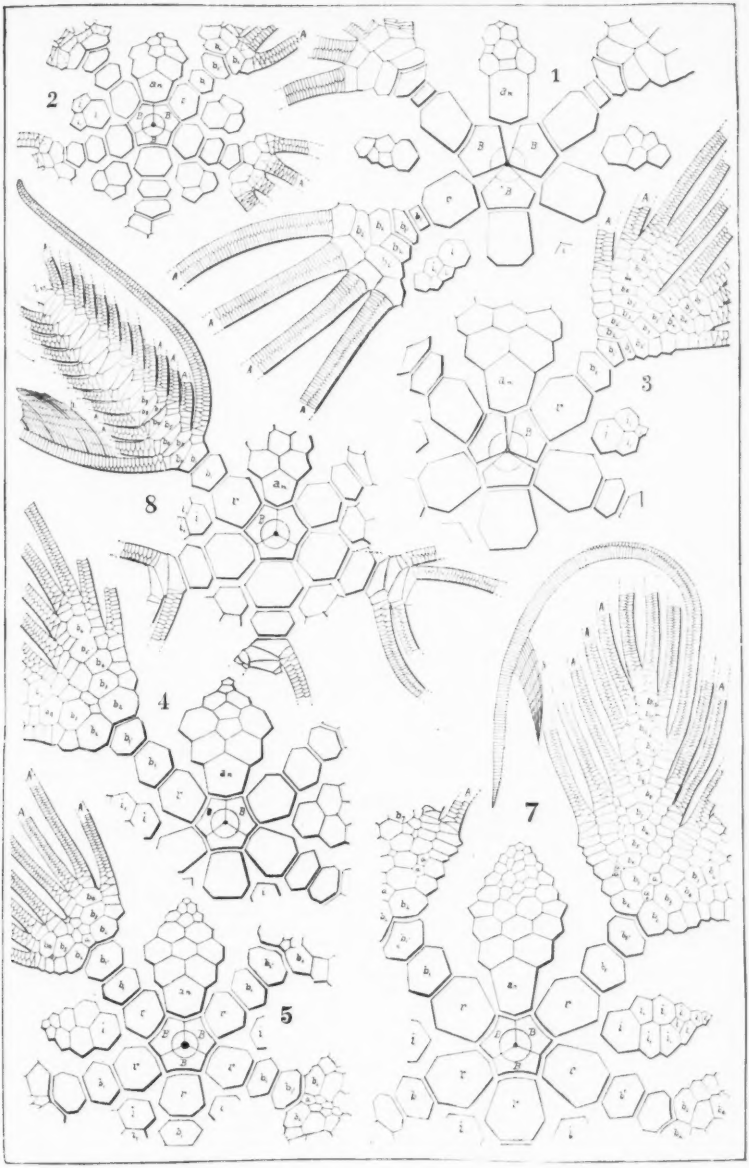
Batocrinus is one of the most characteristic and widely spread forms of the family occurring in the lower Carboniferous. Its relations to the other genera have already been considered elsewhere and need not be repeated here.

Actinocrinus is the type of a most remarkable group. The earlier forms bear a close resemblance to those of Batocrinus, but the possession of only two plates in the second anal tier serves readily to distinguish the two genera. As yet it has not been found to occur below the Carboniferous. It early shows a marked tendency to differentiation along the radial lines, assuming most wonderful phases, which culminated in Teleiocrinus, Strotocrinus, and Steganocrinus. The more primitive forms of Actinocrinus have the free arms, as they leave the calyx, nearly at equal distances from one another, In certain species, however, the arms of one ray begin to separate from those of the adjoining rays. Interradial plates still further increase the distance between the clustered free arm bases of the several rays, until finally the calyx has become strongly quinquelobate. The first section gradually diminished in numbers and disappeared in the upper part of the Burlington; but the second continually grows more and more prominent, and ultimately attains huge dimensions before the extinction of the group.

In the upper portion of the Burlington appears a small group of crinoids—Teleiocrinus—possessing all the characters of Actinocrinus except that the lower branchials for some distance have become larger, and appear like calyx plates. These are all firmly anchylosed, and do not give off the fine biserial arms until the fifth or sixth order of brachials. The calyx thus possesses a more or less well-defined lateral extension passing around above the branchial of the second order. This has led to the union of this group with Strotocrinus; but the rim, though very striking and very similar in each, appears to be a separate development in the two genera, rather than different stages of the same feature. In the ornamentation, the ventral structure, and the possession of a very long anal tube the affinities of Teleiocrinus are manifestly much nearer the typical representative of the family than Strotocrinus.

The Physetocrinus type begins to make its appearance in the Kinderhook as a derivative of Actinocrinus. The earliest known divergence, perhaps, is shown best in *A. ornatissimus* W. and Sp. from the lowest member of the lower Carboniferous. In this

PLATE VIII.



AMERICAN ACTINOCRINIDÆ.

form the radial portions of the calyx have already commenced to become somewhat lobate, and the arms to grow longer and more slender. The plates of the ventral side are all quite small, the ovals indistinguishable from the surrounding ossicles; while the pieces around the anal tube are still smaller, indicating that this structure was very short, and in many cases probably did not pro ject much above the ventral dome. The ornamentation of both also presents a close similarity. Some forms of *A. orpusculus* Hall, from the lower part of the Burlington limestone, also show the Physetocrinus facus, but in a much less merked degree Physetocrinus appears to be the line along which Strotocrinus developed into the unique, short-lived forms which are found only in the upper part of the Burlington.

With the calyx alone under consideration Steganocrinus would be immediately referred to Actinocrinus, but the immense, narrow, radial extensions from which spring the free arms are certainly distinctive enough for generic separation. Although in this character the genus, at first sight, departs so far from the other groups of the family, it will be seen on closer examination that the departure is only another phase of what is shown in Strotocrinus, a devergence beginning a little earlier and in a little different direction.

Summary. Several interesting points are disclosed in the foregoing sketch of the American Actinocrinidæ, which have an important bearing upon the consideration of fossil faunas in general. The conclusions here arrived at apply, in the main, to other families of crinoids as well as to the gastropods and other paleozoic forms, though not to so apparent an extent. Considerable information has already been obtained illustrating these phenomena in the groups last mentioned, and will be the subject of future reference.

(1.) It is clearly indicated that a large proportion of the genera date back much further geologically than actual observation shows.

(2.) At times in the phylogenetic history of a group variations appear to go on with broad and rapid strides, and the organisms survive through rapidly changing physical conditions.

When the changes of environment became too rapid, the forms either ceased, to exist or retrograded, became depauperate and finally extinct. Admirable illustrations are found in Batocrinns, Dorycrinus, and especially in the Hexacrinoid genus Dichocrinus.

(3.) Variation may go on in one portion of an organism without materially affecting other parts. This is well shown in Steganocrinus as compared with Actinocrinus, and among the the Platycrinidæ in Eucladocrinus and Platycrinus, in the Rhodocrinidæ by Gilbertsocrinus and Rhodocrinus.

(4.) The Actinocrinidæ show a decided tendency throughout their existence to increase the distal extent of the rays. In some forms it was accomplished by the simple branching of the free arms, as in Megistocrinus, certain Amphoracrini, and a few Actinocrini; by the lateral expansion of the arms, as in Eretmocrinus; or by radial extension of the calyx branchials, as, notably, in Teleiocrinus, Strotocrinus and Steganocrinus. The number of free arms was thus increased from twenty or thirty in the earlier species of Actinocrinus, to forty to sixty in Teleiocrinus, one hundred to one hundred and twenty-five in Strotocrinus, and from one hundred and fifty to two hundred in Steganocrinus.

Explanation of Figures.

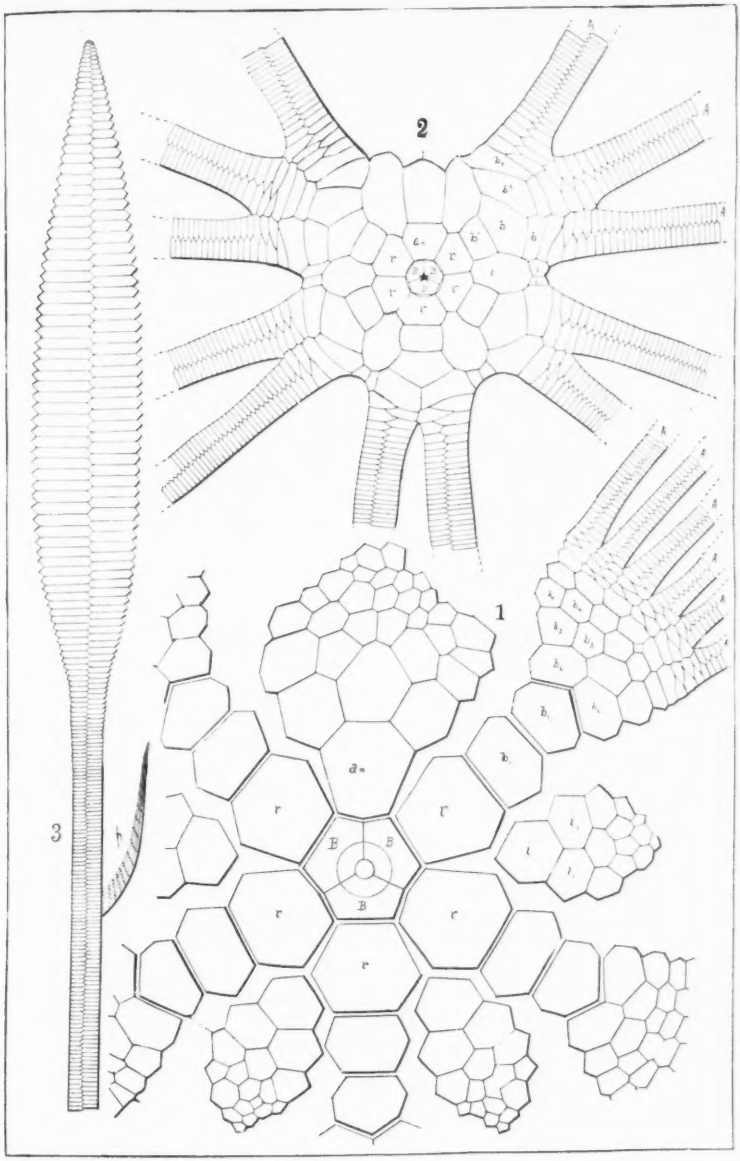
Plate VII.—Graphic representation of the generic relations and distribution in time of the American Actinocrinidæ.

Plate VIII.—Dorsal surfaces of Actinocrinidæ. *B*, basals; *r*, radials; *b*, branchials; *A*, free arms; *i*, interradials; *an*, primary anal plate; *p*, pinnucles; *a*, interaxillaries.

1. *Batocrinus pyriformis* (Shumard). 2. *Actinocrinus proboscidalis*, (Hall.) 3. *A. multiradiatus* (Shumard.) 4. *Teleiocrinus umbrosus* (Hall.) 5. *Physetocrinus ornatus* (Hall.) 7. *Strotocrinus regalis* (Hall.) 8. *Steganocrinus sculptus* (Hall.)

Plate IX.—1. *Megistocrinus evansi* (O. and Sh.) 2. *Agaricocrinus wortheni* (Hall.) 3. Free arm of *Eretmocrinus remibrachiatus* (Hall.)

PLATE IX.



American Actinocrinidæ.

EDITORIAL.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

ACCORDING to Captain Boutelle, U. S. A., superintendent of the National Yellowstone Park, that reservation is fulfilling the purpose of its existence better than ever before. Since the capture and conviction of depredating hunters has become assured, this class of persons have concluded to let the Park alone. Men who might have once played the part of poachers have now become persuaded that it is to their advantage to permit the game in the Park to increase, and furnish a supply for the surrounding region, which will thus continue to be the best hunting ground in America. Captain Boutelle informs us that the large game has become exceedingly tame, the black-tailed deer and wapiti scarcely moving out of the way of the parties who patrol the Park. Bison and moose are also increasing. The immunity from hunters has also encouraged the multiplication of the carnivora. The chief increase is in bears, both black and silver-tip. The slop-barrels and pig-pens of nearly all the hotels are nightly visited, says the Captain, by one or two bears, who divide the supplies with the swine, sometimes eating with them from the trough. So long as they find the necessary douceur, the pigs do not suffer; but if the tax is not paid, an execution is issued and a pig seized to satisfy the debt. Puma and wolverine are also increasing; so that unless some permission to reduce the numbers of the carnivora is obtained, the non-carnivorous game must suffer.

Superintendent of the Fish Commission Col. Macdonald has also determined to experiment on the adaptability of the Park as a fish preserve. Professors Jordan and Gilbert have been examining the distribution of fishes in the Park and the character of its waters, with a view to the introduction of white-fish and grayling, as well as some additional species of trout. It will probably be necessary to introduce also some herbivorous fishes

to serve as a food-basis, as some Catostomidæ, which may be found at similar altitudes of the adjacent regions. Such species (*Catostomus labiatus* e.g.) are found in the Snake River of Idaho, and could be easily procured.

The wisdom of Dr. Hayden in proposing and of Congress in directing the reservation of this tract is abundantly vindicated. It will be well if the Yosemite Park of California can be made equally useful as a game preserve. The time will come when a similar preserve for the game of our Eastern Region will become important. The wild country about the head of some of the eastern tributaries of the Tennessee River in North Carolina furnishes good localities for such a reservation.

RECENT LITERATURE.

A New Text-book of Animal Physiology.[1]—This book, intended "for students of human and comparative (veterinary) medicine and of general biology," is unique in several respects. The subject is treated from the standpoints of general biology and the theory of evolution, and an attempt is made to introduce the comparative method into physiology. There is no doubt that this fundamental idea is the correct one, and that physiological processes, to be fully understood, must be considered as evolutions. That this aspect of the subject has not been greatly accentuated is doubtless due to the fact that physiology has been so long and so universally recognized mainly as the handmaid of hygiene and medicine, hence of necessity *par excellence* human. A change in this respect is inevitable, and is already begun. Investigations of the vital processes, of the mechanics, the physics, the chemistry of the bodies of a few of the higher animals, with especial reference to the human mechanism, have been pushed far within a few years. But a slowing—not a stoppage—of such investigations must, sooner or later, take place; and investigators will more and more ask themselves how have these wonderful and complex vital, these mechanical, physical, and chemical processes of the highest animal body come

[1] A Text-book of Animal Physiology, by Wesley Mills. Pp. 700; New York: D. Appleton & Co., 1889.

to be? Any attempt, like the present, to bring about this change is to be welcomed and commended.

The book begins with a discussion of questions of general biology, such as the cell, yeast, protococcus, amœba, fungi, bacteria, vorticella, hydra, classification of animals, and theory of evolution. Starting then from the ovum and spermatozoon, reproduction is fully treated; a short discussion of the prominent theories of heredity completing the subject. A chapter on the chemical constitution of the animal body, and one on physiological research and physiological reasoning, are followed by a full and orderly treatment of each of the systems of organs found in the body.

Facts are intentionally stated with not too great, sometimes with insufficient, detail, and are discussed impartially, intelligently, and broadly. Occasional want of clearness and disregard of the rules of rhetoric may be remedied in a second edition. Caution is constantly expressed against the acceptance of purely physical, mechanical, and also simple explanations of vital processes, as witness: "The complexity of vital processes is great beyond our comprehension." "The laws of physiology cannot be laid down in the rigid way that has prevailed to so large an extent up to the present time." "And if in this, the best-studied case [secretion in the salivary glands], mechanical theories of vital processes utterly fail, why attempt to fasten them upon other glands, as the kidneys or the lungs, or, indeed, apply such crude conceptions to the subtle processes of living protoplasm anywhere or in any form?" The author's doubts are suggestive. One cannot repress the thought, however, that much of the discussions is written for and is more fitting for the professional physiologist than the inexperienced student. The latter is everywhere made "expectant of progress." Self-observation, testing of facts wherever possible on one's own body, is constantly urged, as well as the comparative study of animal mechanisms. The illustrations are abundant, generally well-chosen, and excellently reproduced. The original diagrams are valuable. The causation of the heart-beat—a field in which the author himself has worked—is well summed up. Gaskell's idea of the cardiac vagus and sympathetic, as respectively anabolic and katabolic, is practically accepted; and the same physiologist's views as to the nature and relations of the cranial, spinal, and sympathetic nerves are given and commended. The discussion of the influence of the nervous system on metabolism is original and interesting. Throughout the book the author has thought his own way. His doubts and his frequent lack of acceptance of conventional ideas will call forth opposition, but his work is suggestive and stimulating.

Johnson's "How Crops Grow."[1]—Twenty-two years ago the first edition of this book appeared, and immediately took a place among the necessary things for the student of plants. It gave, in compact form, an introduction to the chemical composition, structure, and physiology of the higher plants. It was the only American book which took note of the later work of the German investigations in plant anatomy and physiology. It was deservedly popular, and brought its author great credit.

Now, after these years of trial, it is revised and reprinted, the new matter rendering necessary an entire resetting of the whole. In some parts the modernization of the work has been quite notable, in others this is not as marked, while some portions have been allowed to remain as they were left when first written. In the chapter treating of the volatile part of plants, the changes are most marked and interesting. Here eight classes of "proximate principles" are recognized, as follows: Water, the carbohydrates, the vegetable acids, the fats and oils, the albuminoid or protein bodies and ferments, the acids, the alkaloids, and the phosphorized substances. In the treatment of the carbhoydrates, three sub-divisions are recognized, viz.:

(a) *The Amyloses*, having the formula $(C_6H_{10}O_5)N$, and including cellulose, starch, inulin, glycogen, the dextrine, and the gums (the latter including the pectin bodies).

(b) *The Glucoses*, having the formula $C_6H_{12}O_6$ and including levulose (fruit sugar), dextrose (grape sugar), galactose, mannose and arabinose.

(c) *The Sucroses*, having the formula, mostly, $C_{12}H_{22}O_{11}$, and including saccharose (cane sugar), maltose (malt sugar), lactose (milk sugar), and raffinose.

The vegetable acids fall into several groups, viz.: The *fatty acids* (acetic, butyric, etc.), and the *oxyfatty acids* (glycollic, lactic), both of which are monobasic, and the *dibasic acids* (oxalic, malic, tartaric, citric, etc.). The treatment of the protein bodies is likewise practically new, to which nearly twice as many pages are given in the new book as were assigned to it in the old one.

Passing over much that is new in succeeding chapters, we take up the second part, devoted to the structure and physiology of the plant.

[1] How Crops Grow; a Treatise on the Chemical Composition, Structure, and Life of the Plant, for Students of Agriculture, with numerous illustrations and tables of analyses, by Samuel W. Johnson, M. A., Professor of Theoretical and Agricultural Chemistry in the Sheffield Scientific School of Yale University; Director of the Connecticut Agricultural Experiment Station; Member of the National Academy of Science. New York: Orange Judd Company, 751 Broadway. 12mo., pp. VI. and 416.

Here the changes are fewer. The antiquated term "spongiole" is still preserved (p. 257), though for what purpose is not clear. The root-cap, immediately following, is not properly described. On page 310 we still find the statement that about 100,000 stomata "may be counted on an average-sized apple leaf," when, as a matter of fact, it has been known that there are more than that many *on each square inch*. Morren's figures are 246 per square millimeter (*Pringheim's Jahrbüchen für wissens. Botanik*, Vol. IV., p. 190), and these are equivalent to 158,670 per square inch.

The paragraphs on fertilization and hybridization have been entirely rewritten, while that on species has undergone a significant change. Twenty years ago our author wrote the original pamphlet in such away as to involve "original and permanent differences between different species." Then he cautiously admitted a short paragraph about "Darwin's Hypothesis," which he said "is now accepted by many naturalists;" but he says further, in a deprecatory tone, "our object here is not to discuss this intricate question," etc., etc. In comparing these cautious, not to say timid, references in the first edition to the modern idea of the evolution of species, with the treatment of the subject in the new book, one is able to realize the progress we have made in the last score of years. Now the old doctrine is spoken of in the *past tense!* "Such supposed original kinds were called species" (p. 325). A little further on, in referring to the present view, we find this: "On this view a plant species comprises a number of individuals, among which we are unable to distinguish greater differences than experience shows us we should find among a number of plants raised from the seed of the same parent." A very good definition of a species is this. CHARLES E. BESSEY.

New Hand-Books of Paleontology.[3]—The rapid development of the science of Paleontology in recent years, has been naturally followed by the production of text-books which are designed to bring the subject within reach of students and readers. The three works here referred to have the advantage over many similar publications of being the production of experts in the science, and not of mere

[3] *Elemente der Paleontologie von Steinmann und Döderlein;* Strassburg, 1890, 8vo, pp. 829.

Handbuch des Paleontologie, herausg. von Prof. K. A. von Zittel mit Wirkung von Dr. A. Schenk. I. Abth., Paleozoölogie. III. Band; 3 Lief. Reptilen, 1st part, pp. 437–632, 1889.

Manual of Paleontology for the use of Students; by R. A. Nicholson and R. Lydekker; 2 vols., 8vo., pp. 1654; William Blackwood & Sons, Edinburgh and London, 1889.

compilers with no critical knowledge. We have already reviewed the numbers of Professor von Zittel's work as they have appeared, and we now direct attention to the part which includes the first half of the Reptilia. In the arrangement of the class he adopts the following ordinal groups and names: Ichthyosauria, Sauropterygia, Testudinata, Theromora, Rhynchocephalia, Lepidosauria, Crocodilia, Dinosauria, Pterosauria. On this we observe that the name Sauropterygia is antedated by the Plesiosauria of DeBlainville, and Lepidosauria by both the Squamata of Merrem and the Streptostylica of Stannius. In the treatment of the subject Dr. von Zittel has incorporated the latest information from all sources, and has produced the best summary of it now extant. The work meets our approval more entirely than the parts devoted to the fishes and the Batrachia. In the Testudinata we find the results of the recent work done by Dr. Baur, and in the Theromora much is derived from the writings of Seeley. Lydekker is extensively quoted for the Plesiosauria, and American authors are used where necessary. The illustrations are numerous and excellent.

The work of Dr. Döderlein is more compact than that of von Zittel, the families being represented by a few selected genera, no attempt being made to enumerate all of those which are known. The result is a work of less utility to the special student, but of more practical value to the reader who wishes to know only the *capita rerum*. The system of the fishes is considerably in advance of that of the other text-books, since the supposed order of "Ganoidea" is not adopted, and the division Teleostomi is accepted as one of the primary divisions of fishes, a position to which it is undoubtedly entitled. We find the system of the Reptilia a little less full than that of von Zittel, but that of the Batrachia is less open to criticism. The Mammalia are excellent, and the latest information has been incorporated.

The Manual of Drs. Nicholson and Lydekker is of especial importance as the only work of the kind in the English language. We had occasion to review unfavorably the first edition of the work a few years ago, but we must give a different reception to this new third edition. The book has been completely rewritten, and greatly improved in every respect. The department of Vertebrata is, in fact, a new work, the excellence of which is guaranteed by the authorship of Dr. Richard Lydekker. The illustrations are numerous and good, and there is very little in the science which is not in some way referred to in the text. For any but the use of the book as one of reference, many of the genera are too briefly mentioned. The work is not without faults. The systematic, especially that of the fishes, is frequently not quite up

to the requirements of the subject, and the arrangement of the subject-matter is disorderly. We find also an unexpected number of errors of statement in points of American paleontology, as in stratigraphical and geographical position, and in opinions expressed by American authors. We regret that both Drs. Lydekker and Döderlein have reproduced figures of the skeleton of "*Uintatherium ingens*" Marsh; since this fossil is said to consist chiefly of a drawing, modeled after the *Loxolophodon mirabilis* Marsh. C.

RECENT BOOKS AND PAMPHLETS.

MARK, E. L.—Trichinæ in Swine. Extract Twentieth Report Mass. State Board of Health. From the author.

GARMAN, H.—Animals of the Waters of the Mississippi Bottoms. From the author.

MERRIAM, C. HART, AND BURROWS, W. B.—The English Sparrow in North America. Dept. of Agriculture Bulletin, No. 1. From the author.

RYDER, JOHN A.—The Origin and Meaning of Sex. Ext. Proc. A. N. S., Phila. From the author.

SMITH, S. I.—Oscar Harger. From the author.

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General Notes.

GEOGRAPHY AND TRAVEL.

Africa.—Lake Tanganyika.—According to Mr. E. C. Hore, Lake Tanganyika, although there is one African lake the water of which stands at a higher level, has the highest watershed in the continent, and the depression which is enclosed by this watershed, including the hilly table-land of Unyamwezi, may be regarded as the central basin of Africa. The crest of this steep watershed hugs the lake on its western side, but on the eastern is at a considerable distance from it, surrounding the hilly plateau inhabited by the Wanyanwezi. Until recently there was no natural outlet to this lake, but of recent years the waters seem to have risen higher than ever before, until they at length burst open an outlet at a low point upon the eastern shore, where the strata were soft. This gap is the Lukuga River, about which so much has been written, and through it the surplus waters of the lake flow to add their volume to that of the Congo. The barrier once burst, the lake waters have continued their work of cutting down the soft clay, and evidently will continue to do so until the hard rock is reached. At the time of the visit of Commander Cameron, the lake seems to have been higher than it had ever been before, for its recession reveals the stumps of trees that once flourished around the margin. The water level is now eighteen feet lower than it was in 1878; and while of the lower ten feet of this space five is occupied by the stumps of dead trees, the lower five feet is without trees, showing that the present level is lower than any previous one. The Lukuga is now flowing more slowly than it has been. Much of the scenery around the lake is of the grandest description, as might be expected from its position at the bottom of a long north and south chasm. Severe storms sometimes arise, which the natives ride out by jumping overboard and holding on by the boat.

Around this lake, besides the apparently more ancient inhabitants, the Wanyamwezi, who have a horror of water, are grouped representatives of all the African families, the Bantu or Kaffir, the negro, the Semitico-Africano, the dwarfs, and that unclassified group to which the Masai belong. Most of these tribes are expert in the management of their canoes, and thus contrast strongly with the original inhabitants.

The Bissougas.—E. Stallibras (Proc. Roy. Geog. Soc.) gives an account of the Islands of Bijouja, or Bissouga, situate upon the West African coast, in the deltas of the Jeba, Bolola, and Cassini rivers. The largest of these, Orango, is twenty miles long by ten in width, and others are Kanabek, Formosa, Corbelha, and Karashe. All these consist of decomposed volcanic soil, and are thickly covered with wood. Other islands near the Jeba mouth are Bissao, Bassis, and Jatt, while near that of the Bololo are Bissagua, Biafares, Bulama, &c., many of them at present unexplored.

The Portuguese established a fort on Bissao about 1703, but it was afterwards abandoned. In 1792 the English established a colony at Point Beaver, but it proved a complete failure. After this they started a colony upon Bulama, but the islands were by the arbitration of the United States adjudged to Portugal, and the English left in 1868. The present condition of the islands, according to our author, is not flourishing, yet they have a submarine cable.

Stanley's Discoveries.—The letters of Mr. Stanley, published in all the papers, have made the principal points of his discoveries during his last expedition so familiar to every one that it seems superfluous to go over the same ground. Yet there is something strangely fascinating in the encounter, at the head of the Albert Nyanza, and on the eastern flank of the Semliki, which connects that lake with the smaller and more southerly one which Stanley would have us call the Albert Edward, of a snow-capped mountain, believed by its discoverer to be the same as the almost fabulous Mountains of the Moon. Whether subsequent researches will confirm or invalidate Stanley's conclusions in this matter remains to be proved, but in the meantime we can be certain that another peak of 15,000 feet in height is added to those which recent years have revealed in the heart of Africa, and also that another affluent of the great river has been discovered.

The Congo Railway.—Captain Thys has, in a recent issue of the Proceedings of the Royal Geographical Society, given some interesting particulars regarding the Congo Railway, which is to commence at Matadi, a point that can be reached by steamers, and will finish at Ndolo, above the uppermost rapid. The cost of this railroad is said to have been most liberally estimated, yet will not exceed £1,000,000. The most formidable difficulties are encountered in the first twenty-six kilometres of the road, the total length of which will be 435 kilometres.

The Italian Protectorate.—In the partition of the coasts of Africa among the European powers, with undefined claims ex-

tending into the interior, Italy has not been forgotten. Her territory around Massowah has been extended to 18.2 N. Lat., while it stretches southward to the southern boundary of Baliata, and thus contains 200,000 inhabitants. The Habab, Beni Amer, and other tribes are also said to have recently recognized the Italian protectorate.

On the Somali coast her protectorate extends from the Zanzibar district of Warshekh in 2.30 N. Lat., to Wadi Nogal in 8.3 N. Lat. It is also said that the Sultan of the Midjertin-Somal, whose territory reaches from Ras Hafim, has placed the northern part of his dominions under the protection of Italy.

Lake Rudolph.—Von Hohnel, arguing from the accounts given by Sr. Borelli and Count Teleki, considers it provable that the River Omo of the former falls into Lake Rudolph, discovered by the latter. Lake Rudolph extends from 2.16 to 4.47 N. Lat., and has an area of about 3050 square miles. It is surrounded by a flat desert country, but towards the north the level varies, and at this end enter two perennial streams, the Bass and the Niam-niam. The Niam-niam is about 100 yards wide in its lower course, and has a slight current, while the Pass, the lower course of which is parallel to the former river, has a width of about a mile and a quarter, but is shallow, and has no perceptible current. At the southern end of the lake two streams also enter, but these are dry save in the wet season. Their names are the Irrquell and Kecio. The lake has no outlet, and it is the Niam-niam which is believed to be Borelli's Omo. The description given by Borelli of Lake Shambara, into which he traced the Omo, does not accord with Lake Rudolph, but Lake Shambara is said to have an outlet, and Von Hohnen believes that the Omo flows through it into Lake Rudolph or Basso Narok. A few miles northeast of Lake Rudolph is a smaller lake, one-eighth the size of the former, and known as Basso Ebor or Lake Stephanie. This also has no outlet, and is rapidly drying up.

In the *Zeitschrift der Gesellschaft für Erdkunde* (Berlin), Paul Reichard gives a long account of the Wanyamwezi of the plateau east of Tanganyika, their physical characters, customs, and modes of life.

The French geographers are greatly elated that at last, after most of the difficulties of the way have been surmounted by others, a French traveler, M. Trivier, has crossed the African continent, passing up the Congo by Stanley Pool and Tippoo-Tib's quarters, and debouching at Mozambique. The editor of the *Revue Géographique*, in recounting the details of the trip, has some remarks to make respecting

the probable ulterior objects of Stanley's expedition—remarks that seem not unlikely to be founded on fact.

Captain V. Nicolasis is contributing to the *Revue Géographique* a series of articles upon West and South Madagascar.

Asia.—The Bahrein Islands.—M. J. Theodore Bent (Proc. Roy. Geog. Soc.) gives a description of the Bahrein Islands in the Persian Gulf, upon the Arabian coast. The pearl fisheries of these islands have been famous from the days of Nearchus until now, and who has not heard of the subaqueous springs of fresh water upon their coast?

Mr. Bent was, however, impelled to investigate the group from archeological reasons, his object being to search some of the numerous mounds which are to be found in them, notably in Bahrein itself. This island is twenty-seven miles long and ten wide, Moharek is five miles in length, and has a width of half a mile, while the rest are mere rocks. Among these are Sayeh, Khasafeh, Manaweh and Arad, the latter a Phœnician name. Bahrein has a population of about 8,000, and the group is governed by an hereditary Sheikh, who is now under the protection of Britain. Bahrein has many subterranean springs, related in their nature to those which in some places rise under the surface of the gulf. The first European nation to put in an appearance at this group was the Portuguese, who came under Albuquerque in 1506, and whose power lasted until 1622, when Shah Abbas, assisted by an English fleet, took Hormuz and Bahrein. The islands fell into the power of the Arabs in 1711.

The extensive group of mounds, some of which were explored by Mr. Bent, is situated near the village of Ali, and examples reach a height of forty feet. After digging through hard earth for fifteen feet, a layer of loose stones two feet thick was met with, then one of decayed palm branches. Under these a two-story tomb, the lower chamber higher than the upper, was discovered, and its structure was so similar to that of Phœnician tombs in general as to lend support to the idea that these islands were either the original home of that people, or at least one of their earliest settlements. The upper chamber contained fragments of ivory, bits of a statue of a bull, circular boxes, etc., in a word the treasures of the deceased, whose body was buried in the lower chamber where traces of bones were found, together with the decayed remnants of drapery and remains of the wooden pins used to fasten it to the walls.

The Prejevalsky Expedition.—The Russian exploring expedition, formerly conducted by the lamented Prejevalsky, is now under the command of Col. Pievsoff, who is continuing the work energetically. Letters have been forwarded to the Royal Geographical Society by Lieut. Roborovsky. The expedition left Prjevalsk May 13th, and after passing Silvkina ascended the Barskounski Pass, traveled for a week over an elevated sirt 10,000 to 11,000 feet above the sea, crossed the Tauskan Daria, and then proceeded towards Yarkand. The Kashgar Daria no longer reaches the Yarkand, but is lost in irrigation canals at Marat-bash. The flat banks of the Yarkand are bordered with a belt of vegetation fifteen to twenty miles in width on each side, including two species of poplar and Holostachus. Many ruins of old and unknown cities are to be found in these deserts, the thickets abound in tigers and boars, and wild camels graze on the barkhans around.

The town of Yarkand consists of an old Mahometan city with thirty to forty thousand inhabitants, and a new Chinese city. The water is very bad and there is much goitre. Passing Khoten Col. Pievtsoff has reached Nia, where he will winter, and then search for a route into Tibet over the Taguz-Daban range, some of the peaks of which were estimated by Prejevalsky at 22,000 to 23,000 feet.

A large portion of the November number of the Proceedings of the Royal Geographical Society is occupied by the diary of the journeyings of David Linsday in the interior of Australia, which he crossed from north to south, keeping within the boundaries of the colony of South Australia somewhat to the west of Queensland. The account is accompanied by a map of the route with the survey lines given. There is also a glossary of native words.

Dr. Hagen traces the Malays to West Sumatra, and believes that the present natives of the interior of the large islands (the Dyaks of Borneo, etc.) were the first emigrants from the original site, and crushed out the negritos in the countries occupied by them. This migration was followed by others, the last emigration of the Malays taking place about the twelfth to the fifteenth century. The purest Malay type is to be seen in the Battas and Allas of Sumatra.

A series of articles by A. de Leanarde upon the country of the Amur and the Ossory is completed in the *Revue Geographique*, of January, 1890.

A recent issue of the Proceedings of the Royal Geographical Society, gives the heights of some of the principal summits of New Guinea. Mount Victoria, ascended by Sir W. Macgregor on the 11th of June, 1889, is 13,121 feet hig; Mt. Albert Edward, 12,500; Mt. Scratchley, 12,000; Mt. Knutsford, 11,157; Mt. Douglas, 11,796; Mt. Griffiths, 11,000; and Mts. McIlwraith and Morehead, ten to eleven thousand feet.

Europe.—Cyprus.—The British governor of Cyprus, Sir R. Biddulph, gives in the Proceedings of the Royal Geographical Society an interesting account of that recent acquisition of the British Empire.

The peculiar form of the island is due to the existence of two ranges of mountains; the one long and narrow, hugging the northern shore at a distance of only about two miles, and the other broader and shorter, placed somewhat to the westward of the former, and considerably to the south. The space between these two ranges is occupied by a broad fertile plain known as the Mesaorea. The northern range terminates westward at Cape Kormakiti, and eastward at Cape San Andrea. One of its highest peaks, Kornos, is 3105 feet. An abundant stream, issuing at a height of 870 feet on the southern side, waters the thriving village of Kythrea, and another, issuing on the northern slope, waters the two flourishing villages of Lapithos and Caravas. The southern range is not only more extensive than the northern, but its summits are loftier. The eastern point of this range is the Mountain of the Holy Cross, crowned by the monastery of Santa Croce, and conspicuous from the harbor of Famagusta. This peak is less than three thousand feet, but Mt. Machera to the westward is 4674; while Mt. Adelphe, still further to the west, is 5305 feet, aud the culminating point, Mt. Troonos, still more to the west, is 6406 feet. This extensive mountain area, which in some places is more than twenty miles wide, was once covered with forest, but the greater part of this has been cut down, to the great detriment of the fertility of the island, so that most of the woods now remaining are west of the summit of Mt. Troodos, in the western and widest portion of the range. A few moufflon still exist in the wildest parts of these mouutains. Most of the rivers flow only after the rains. The largest are the Pediæus, which rises on the northern slope of Mt. Machera, and passes by the capital, Nicosia, and the Idalia, which has its sources on the eastern slopes of the same mountain. Both of these fall into the sea near the ruins of the ancient town of Salamis, and not far from Famagusta. Another stream, rising on the slopes of Mt. Adelphe, enters the sea on the western shore, near the populous village of Morrphou.

The chief causes of the disappearance of the forests are recent, and are indiscriminate wood-cutting, and goats. The island has more goats in proportion to population than any other part of Europe. It is also cursed with a peculiar small species of locust, which a few years since devastated the crops most fearfully, but has, during the last three or four years, been very successfully and energetically fought. The population of Cyprus under Venetian rule is said to have been two millions, though one seems more probable. At the present time, though numbers have increased under British rule, there are not more than 186,000, one-fourth of whom are Mahometans. This island has always been famous for its wines, for the sake of which Sultan Selim sent an army against it, and after an heroic resistance, ceasing only when the city of Famagusta had been sacked, and its brave defender Bragadino flayed alive, succeeded in reducing it under Moslem sway. One million six hundred thousand gallons of this wine are still made annually, but in a most primitive fashion, and four-fifths of this is exported. The whole of the land is divided into small holdings, of which there are 600,000 in all, so that there are more than three to each individual. The houses are, as a rule, built of sun-dried bricks. The capital, Nicosia, has 12,000 inhabitants; Larnaca, on the eastern coast, has 7,000; and Limassol, the southern port, has 6,000. The most interesting ruins are those of three castles of the times of the crusaders, and the oldest complete existing monastery is that of Santa Croce.

The Caucasus.—The Caucasus, with its peaks higher than the Alps, and a glacier system to which that of the better known mountains offers no comparison, is now the favored climbing-ground of Alpinists. During 1889, five elevated passes were crossed by Messrs. David Freshfield and Captain Powell. Among these, that of Saluinan-Chiran is at an elevation of 13,622 feet; while two others attain heights of 14,300 and 13,000 feet respectively. Mr. Herman Woolley ascended Dych-tau (14,923), and the eastern peak of Misahirgi-tau (16,100); while Vittorio and Erminio Sella climbed Elbruz and Malatau (15,351; this was the first ascension); also, together with Messrs. D. Freshfield and Powell, the peak of Leila (13,300).

Arctic Regions.—According to Dr. W. Kukenthal and A. Watter, the existing maps are in error regarding the two or three islands which form King Charles' Land. The latitude of these islands is 78.30 to 78.57 N., and the longitude 26.20 to 26.30 E. The east coast should thus be set back about 11 minutes.

The geology of King Charles' Land is allied to that of Spitzbergen. In the land lakes there are many insects and crustacea, but the mammals are only the usual ones of the arctic regions; bear, walrus, and seal are plentiful. There are a few mosses, which form the only vegetation.

The *Zoölogist* (Jan.) gives an account of the birds of Jan Mayen, translated from a paper by Dr. Fischer, of Vienna. This island is located in latitude 70.49 to 71.8 N., and longitude 7.26 to 8.44 west, and is 600 miles due north of the Faroe Isles. In color and character it much resembles Spitzbergen. At one part there are two volcanoes in close proximity, and at the northern end rises the mountain of Beerenberg, 6870 feet in height. Plants are scarce, and though many migrants visit the island, only sea-birds breed there regularly. Among the birds are *Falco candicans* and *F. peregrinus*, *Nyctea nivea*, *Erithacus rubecula*, *Saxifraga œnanthe*, *Turdus pilaris*, and *T. musicus*, *Motacilla alba*, *Anthus aquaticus*, and *Linota hornemanni*,—the latter a true Arctic species. Many waders occur, and here is the most northern recorded habitat of *Rallus aquaticus*. Many swimmers breed here, but only *Fulmarus glacialis* stays here all the year.

Mr. Thoruddsen, who is himself a native of Iceland, has recently devoted his time to the exploration of this still imperfectly known large island. In 1889 he explored the region of Fiskivotn, a waste between Hecla and Vatna Jokul, before for the most part unvisited. East and north of Hecla he found a new obsidian district. Crossing the Tunguaa, he visited the true crater lakes of Fiskivotn. In the district between these lakes and the Vatna Jokul there is no plant life; the entire area is covered with lava floods, with a large amount of volcanic sand. Lake Thorisvatn in this region is the second largest lake in the island. After a day's journey in an utterly desolate district, M. Thoroddsen discovered the sources of the Tunguaa, and south of this, between three ranges of before unknown hills, he found a long and narrow lake.

Miscellaneous.—No. 143 of the *Zeitschrift Gesell. f. Erdkunde* contains Dr. Polakowsky's account of the Central American State of Honduras, the first of a promised series upon these republics. This republic, which has a population of 331,917, is loaded by a large debt incurred on account of the inter-oceanic railway.

Mexico now has 4700 miles of railway, Brazil 6000, Peru 3000, Chili 1630, the Argentine Republic 4700, and the smaller republics

about 1500 miles, making a grand total of about 17,000 miles of railroads in operation in South America.

Sir F. de Winton also states that the railway mileage of Australia reaches 11,000.

GEOLOGY AND PALEONTOLOGY.

Seeley's Researches on the Organization, Structure, and Classification of the Fossil Reptilia.[1]—The Royal Society of Great Britain granted Prof. H. G. Seeley a sum to be expended in prosecuting researches among the extinct Reptilia, and the results obtained up to the present time are embodied in the memoirs now before us.

The first is on that ancient form, both geologically and in the literature, the *Protorosaurus speneri*. From the upper Permian of Germany, no form is more worthy of investigation, but the character of the matrix is such as to render the elucidation of the characters of the skeleton difficult. Dr. Seeley concludes that the genus Protorosaurus has no affinity with any form of reptiles known to him. His figures and descriptions add much to our knowledge of its characters, and, as a result, its place appears to me to be nearer to other genera of Permian age of Europe and South Africa. Accordingly I have (NATURALIST, October, 1889) placed it with them in the Theromora, to which location its characters distinctly point.

The second paper describes that remarkable form *Pariasaurus bombidens* Owen, from the Karoo Series of South Africa, which is of Permian or Triassic age. The new investigation is based on a nearly perfect skeleton in the collection of the British Museum, and the information furnished elucidates the systematic position of the genus almost completely. Dr. Seeley concludes that it belongs to the Theromora "Anomodontia"), and to a subdivision of that order which he calls the Pareiasauria. The characters of this suborder are as follows (p. 292, Philos. Trans., 1889, p. 292): "Occipital" condyle "basioccipital; no temporal vacuities; no median bar to interclavicle."[2] He shows that the ribs are single-headed, and attached to the diapophyses

[1] I. On *Protorosaurus speneri* Von Meyer (1887). II. On *Pariasaurus bombidens* Owen (1888). III. On *Theriodesmus phylarchus* Seeley (1888). IV. On the Anomodont Reptiles and their allies (1889). All from the Philosophical Transactions of the Royal Society, 1887–9.

[2] For scapular arch of Diadectes, see Proc. Amer. Philos. Society, 1883, p. 635.

only, and that intercentra are present. This reference by Dr. Seeley is essentially final, the only question being the minor one of the name of the suborder. In all important respects Pareiasaurus agrees with the Diadectidae, hitherto known only from the Permian formation of North America, and must be placed in the same sub-order. In the American forms the temporal fossa is overroofed in the same manner, and the ribs are single-headed. The articular face of the diapophysis is, however, prolonged downwards to the level of the centrum in the Diadectidæ, though it originates entirely from the neural arch. Both types must be placed together in the suborder Cotylosauria, a name which has priority over Pariasauria. To the same order must be referred the genus Phanerosaurus Von Meyer, from the Permian of Saxony. In his studies of the relations of the intercentra to the vertebræ and the occipital condyle, Dr. Seeley has quite overlooked my own conclusions, with which he agrees, which I published in 1884[3] and 1886[4].

The memoir on the Theromorous reptiles ("Anomodontia") covers a wider range than those above mentioned, and concludes with some general conclusions as to the systematic arrangement of the order. Especially important is the description of the scapular arch in Procolophon, which turns out to have a well-developed coracoid and separate epicoracoid, which, with the clavicle and interclavicle, give the most monotrematous shoulder-girdle yet seen in the Theromora. Other important contributions are the descriptions of limb-bones and shoulder and pelvic girdles in Dicynodon, Hyorhynchus, Eurycarpus, etc. There is more information as to the characters of the skeleton of the South African Theromora to be found here than in any memoir yet published. In the systematic, several new divisions are introduced. The first, the Procolophonina, may turn out to be included in Baur's Proganosauria; but it is manifestly as well distinguished from the Pelycosauria, Cotylosauria, Anomodontia, and Placodontia as these are from each other. For the entire order Dr. Seeley uses the name Anomodontia, which we think should be restricted to the group to which Professor Owen originally gave it, viz.: the Dicynodontia of Seeley. The Gennetotheria (Seeley) do not seem to me to be distinguished from the Theriodonta of Owen, with which the Pelycosauria is more or

[3] AMERICAN NATURALIST, p. 37, On the Batrachia of the Permian period of N. America.

[4] Transac. American Philosoph. Society, p. 243, On the Intercentrum of the Terrestrial Vertebrata.

less coëxtensive, especially after the removal from them of the Cotylosauria.

The affinity to the Mammalia which Professor Owen saw in the humerus, and which I have pointed out in the skull, shoulder-girdle, fore-limbs, and hind-limbs and foot, is confirmed by Seeley's researches. He finds a fore-limb and foot of what he believes to be a veritable mammal in the same beds of the Cape, which is the subject of his third memoir, and which he refers to a species and genus under the name of *Theriodesmus phylarchus*. The probability of this determination being correct appears to me to be strong. The humero-cubital articulation is mammalian, and there is nothing in the pes forbidding the association. Dr. Bardeleben thinks that it has a præpollex with metacarpal and phalange. On this interpretation there is one large *os centrale*.

We are gratified to learn that Dr. Seeley has accepted the position of Director of the Geological Survey of the Cape, and we feel sure that important discoveries await him there in his chosen field.

E. D. Cope.

Devonian.—The *Geological Magazine* for January has some pretty full notes by Dr. R. H. Traquair upon some Devonian fishes from Scaumenac Bay and Campbelltown, now contained in the Edinburgh Museum. Most of the species have been described by Professor Whiteaves, but these notes give much information upon the Ctenodontidæ, Cephalaspidæ, Acanthodidæ, Holoptychidæ, Pleurichthiidæ, Palæoniscidæ, etc.

Mesozoic.—S. Nitchin gives an account of the Jurassic beds of the Himalayas and Middle Asia. The principal development of the Jurassic in the Himalayas is on the north-east slopes of the southern crystalline chain near Spiti and Niti, where dark crumbling shales known as the Spiti shales rest on beds said to be Lias and Rhætic. Phosphatic concretions are abundant, and ammonites plentiful. Opinions differ about the parallelism of the horizon, but it is generally thought that these shales are of the age of the Kelloway and Oxford clays. Nitchen thinks them more recent, and states that their fauna approaches nearest to that of the Tithon and Kimmeridge. The fauna of the Russian Jurassic is near that of Cutch.

Professor A. Pavloff believes that the Upper Jurassic of Russia is so near that of England that a common classification might be adopted. He describes as new three species of Cleostephanus, viz., *C. blaki*, *swindonensis* and *stenomphalus*.

M. G. Cotteau, after having described the Cretaceous echini of France, has now commenced with those of Spain. In Vol. VII., No. I.*, of the *Ann. de Sci. Nat.*, he treats of those collected in Oregon by M. Maur. Gourdon. The species are in great part identical with those previously described from French rocks.

Tertiary.—The *Revue Géographique* for January contains an account of the defile of the Danube by Attila de Gerundo. The writer believes that parts of this defile, which is 143 kilometres in length, were ancient valleys, and that a series of dislocations, the localities of which are marked by cliffs, at length opened a passage of communication between the Hungarian Sea and the Roumanian Bay of that larger inland sea of which the Black Sea is a remnant. Through this strait the waters of the sea poured, silting up the Roumanian Bay, until, when the outer sea retreated, the current swept the strait clear of sediment, and the Hungarian Sea ceased to exist, being replaced by the river network that at present exists.

A new edition of Dr. Burmeister's work upon the fossil Mammalia of the Argentine Republic, with considerable additions, has been recently issued. The Equidæ differ from all other Pampean ungulates in having the premolars longer than the true molars. Dr. Burmeister places the more generalized species of fossil horses in the genus Hippidium, which is distinguished from the modern Equus by the shorter and more curved crowns of the cheek teeth, which are of more simple general structure. The shape of the narial apertures also differs from that of the existing horses, the limbs are shorter, and the limb-bones stouter. In its teeth Hippidium approaches Hipparion, but the anterior pillar of the cheek teeth is connected with the anterior crescent, which is not the case with the latter genus. The Pliocene *Equus stenonis* of Europe forms a connecting link between Hippidium and Equus. Additional remains of *E. curvidens*, *E. argentinus*, and *E. andium* are described, also a new Hippidium from Tarija in Bolivia. An entire skull of *Megatherium americanum* shows that our previous knowledge of the osteology of that animal was incomplete. In front of the short nasals this skull exhibits a large prenasal reaching almost to the premaxillaries, and there is also, projecting from the upper part of the maxillary, a lateral process coming forward into the nasal aperture. Probably the prenasal became united to the nasal in the adult. Another ossification extends upwards and backwards from the end of the premaxillary towards the prenasal. These two ossifications are the remains of the complete bony arch exhibited by *Mylodon darwini*,

which has been on this account generically separated under the name of Gryptotherium. Dr. Burmeister maintains the distinctness of *Mastodon andium* from *M. humboldti*, the latter attaining a larger size, and having more complex teeth; moreover, the dentine in the first species is always red, while in the second it is white. Remains of *Macrauchenia patachonica* and *M. parañensis* are also described. From the muscular impressions still remaining on the skull it is inferred that the nose was produced into a short proboscis, as in the existing tapir.

According to Dr. Roth's recent description of the structure of the pampean deposits, they contain in different proportions river, wind, lagoon, and coast beds. The coast deposits contain sand and marine shells; the lagoon beds are darker in color, and are much inferior in extent and thickness; while the river deposits, which contain large pebbles near to the mountains, become gradually finer as they recede from them. The beds formed by the few streams rising in the pampas themselves have round, smooth limestone concretions, as well as smooth fragments of bone. The æolic layers have vertical root-like tubes and irregular limestone concretions. The uniform character of the pampas loess does not, therefore, arise from its uniform origin, but from its long subjection to identical influences, to its transformation under the growth and decay of vegetation, and to wind and rain. Water carrying down and packing loose matter often makes the loess of the lower parts harder than that of the higher. In Entre Rios Dr. Roth observed that marine beds, probably of Miocene age, were lying over the typical Pampean, whence he concludes that the formation of the pampas loess commenced in Eocene times, grew in intensity in the diluvial, and is continuing at the present time.

In the *Geological Magazine* for January Mr. H. H. Howorth puts forward the theory that in the mammoth age the great Siberian rivers flowed southward into the central lake-sea.

BOTANY.

Memoirs of the Torrey Botanical Club.—Nearly a year ago the first number of the Memoirs appeared containing Professor Bailey's Studies of Carex. In August following, the second number was issued, containing the Marine Algæ of the New Jersey Coast and adjacent waters of Staten Island, by Isaac C. Martindale. The list is an annotated one, and is based on notes and collections made by the author during a period of twenty years. It embraces 91 genera, 183 species, and 41 varieties.

The third number of the Memoirs reached subscribers late in January. It is devoted to an account, by Richard Spruce, of a collection of the Hepaticæ, collected by Dr. H. H. Rusby on the Eastern slope of the Bolivian Andes in 1885–6. The paper bears the title "Hepaticæ Bolivianæ, in Andibus Boliviæ orientalis, Annis 1885–6, a cl. H. H. Rusby, lectæ." Twenty-two genera, and 97 species are noted; of the latter no less than twenty-five are here described for the first time.

The Missouri Botanical Garden.—The first annual report of the director, Dr. William Trelease, sets forth the objects contemplated and provided for in the will of Mr. Shaw, the founder of the garden. They are briefly as follows:

1. To continue the ornamental features of the garden.
2. To add to its botanical usefulness by additions to the growing plants.
3. To provide for a system of correct labeling.
4. To provide fire-proof quarters for the Engelmann herbarium, and also for additions to the general herbarium.
5. To improve and enlarge the botanical library.
6. To secure a botanical museum.
7. To assist in the completion of the flora of North America, by the publication of monographs.
8. To ultimately provide for research in vegetable histology, physiology and pathology.
9. To make the garden useful for horticultural instruction.
10. To take steps looking to the early appointment of six "garden pupils."

11. Eventually to appoint "associates" to the director, who are to be specialists in some department of Botany.

From surveys made it appears that in the garden proper there are 9.4 acres; in the Arb.retum, 20.5; in the Fruticetum, 8; Old Vegetable Garden, 3.5; Grove, 0.6; Lawn, 2.7; making in all 44.7 acres.

We may hope to see, in time, an American Kew at St. Louis.—CHARLES E. BESSEY.

Ellis' "North American Fungi."—About the middle of February centuries XXIV. and XXV. of this great distribution of the Fungi of North America were distributed to subscribers. It is needless to speak of the fine specimens, or of the neatness with which the mechanical work has been done, for these are already well known to most readers of the NATURALIST.

Century XXIV. contains a few Basidiomycetes (about twenty pieces), the remainder being mostly Ascomycetes. Among the latter is an interesting new species, *Plowrightia symphoricarpi*, occurring on *Symphoricarpus occidentalis* in Montana. Botanists will recognize in this a congener of the familiar Black Knob of the plum.

Century XXV. contains about twenty-five Urdineæ and Ustilagineæ. Among the latter are the interesting *Ustilago andropogonis* of Kellerman and Swingle, and the apparently related *Sorosporium ellisii* of Winter, both infesting the inflorescence of *Andropogon provincialis*. A dozen fine specimens of Slime Moulds (in boxes) closes this vnluable century. —CHARLES E. BESSEY.

Seymour and Earle's Economic Fungi.—During the month of January, the first foretaste of a new distribution of the fungi made its appearance. "The object of this series," the authors say in their announcements, "is chiefly to supply a set of authentic specimens to illustrate the diseases of useful and noxious plants, for the use of Agricultural Experiment Stations, and persons interested in the subject from a practical standpoint." The specimens before us (Nos. 1 to 50) indicate that the authors have done this work well and wisely. Six species affecting Vitaceæ, and twenty-eight upon Rosaceæ, are presented. Of the latter six species affect the Blackberry (*Rubus villosus*).

No station can afford to do without this set, especially when its moderate price of $3.00 per fascicle of fifty specimens is considered. We trust that the authors may meet with encouragement to warrant them in continuing their work.—CHAS. E. BESSEY.

The New Gray's Manual.—It is a significant thing that in bringing out a new edition of the familiar Manual of Botany of the Northern United States, by Asa Gray, the revisers found it necessary to extend its geographical limits westward to the 100th meridian, that is, to the middle of the Great Plains. "The rapid increase of population west of the Mississippi River and the growing need of a manual covering the flora of that section, have seemed a sufficient reason for the extension of the limits of the work westward." This action will relieve the teaching of elementary botany, in the west, of many of its embarrassments. Those who have not tried it, can have little conception of the difficulties encountered by college and high-school teachers in attempting to give to their pupils a knowledge of the local organic flora in the region lying between the Mississippi River and the Rocky Mountains.

By a hasty calculation it appears that the region covered by the Manual has been increased about 70 per cent. The species described have been increased by about 40 per cent.; however this is in part by the addition of the Hepaticæ (141 species), and a number of immigrants not included in the earlier addition. Probably the westward extension of the Manual has given it from 30 to 33 per cent. more species. The total number now described is 3298, of which 405 are said to be introduced.

It is interesting to note where this increase takes place. It appears that the Polypetalæ have gave gained 46 per cent. (289 species), the Gamopetalæ 36 per cent. (271 species), the Apetalæ 64 per cent. (121 species), the Monocotyledons 17 per cent. (115 species). In this increase certain orders stand out prominently; for example: the Leguminosæ are increased from 98 to 156, the Rosaceæ from 72 to 95, the Compositæ from 288 to 407, the Gramineæ from 168 to 250. The Gymnosperms are increased by one only (*Pinus ponderosa Douge, var., scopulorum* Engelm. in Nebraska), while through rigid revision the Cyperaceæ actually number two less than in the old edition.

In glancing through the book one meets many new plants which will have an unfamiliar look to the eastern local botanist. We found, for example, *Argemone platyceras, Cleome integrifolia, Viola nuttallii, Prunus demissa, Mentzelia ornata, Cucurbita fœtidissima, Adoxa moschatellina, Grindelia squarrosa, Aplopappus spinulosus, Eustoma russellianum, Solanum rostratum, Pentstemon cobœa, Amarantus blitoides, Elæagnus argentea, Andropogon hallii, Buchloë dactyloides, Munroa squarrosa*, etc., etc.

There is a marked spirit of conservatism dominating every part of the work. We look in vain for any recognition of the somewhat radical notions which have of late arisen in some quarters. The time-honored arrangement of orders, the time-honored genera, the time-honored rules as to capitalization, punctuation, and citation of authorities, are strictly adhered to. The Gymnosperms are still wedged in between monocotyledons and dicotyledons; Carya is Carya still, and not Hicoria; Nymphæa is Nymphæa still, and not Castalia; and even in so plain a matter as the spelling of Pirus, we have Pyrus, as in the older editions. All this, and much more like it, implies that for many years still the young botanists of America are to be made familiar with the older and quite conservative views of classification and arrangement. We had hoped for something different. Meanwhile we are glad to get the book, for it was much needed.—CHARLES E. BESSEY.

ZOOLOGY.

Zoological News.—General.—The Verhandlungen der Gesellschaft für Erdkunde (Berlin), contains an account of the biological results of the Plankton Expedition of the summer of 1889, by Prof. K. Brandt, and of the voyage itself, by Dr. Krummer. The trip seems to have been confined to the Atlantic, and returned to Kiel on November 7, after an absence of 115 days, and a run of 15,600 miles. The experience of the expedition was that the ocean, even in the tropics, was poorer in life than the North Sea and Baltic.

Protozoa.—The last report in Vol. XXXII. is by Ernst Haeckel, and concerns the curious group of organisms known as the Physemaria. These Haeckel pronounces to be sponges of affinities to the Keratosa, but modified by symbiosis with a commensal which is in most, if not in all cases, a hydro-polyp stock. Four families and eleven genera are described. In the Stannomidæ, examples of which were dredged at depths of from 2,425 to 2,925 fathoms, there is present a fibrillar

spongin skeleton of thin, simple or branched spongin fibrillæ, not anastomizing nor reticulated, together with the usual symbiotic hydroids. Prof. Haeckel believes that these fibrils throw light upon the peculiar filaments of the Hircinidæ. They are monaxial keratose spicules. This report occupies ninety-two pages, and is illustrated by eight plates.

Cœlenterata.—The last volume of the Challenger Zoölogical Reports, Vols. XXXI. and XXXII., have lately been issued. The first of these contains the important report upon the Alcyonaria, by Messrs. Wright and Studer, and the comparatively short account of the pelagic fishes, by Dr. A. Gunther. Of the 189 species of Alcyonarians found by the expedition, 133 are here described as new. From the chapter upon geographical distribution, it appears that the West Indian Isles, the western shores of North America, and the Australian and Japanese seas, are the headquarters of this group. The report occupies 386 pages and is illustrated by 49 plates.

The first report in Vol. XXXII. is by G. Brook, and treats of the little known group of the Antipatharia. As most of the specimens of Antipathes preserved in museums are in a dry and shriveled condition, good diagnoses of the species are rare. Fortunately most of the Challenger examples had the polyps well preserved, and, therefore, a partial revision of the tribe has been attempted, and the classification put upon a correct natural basis. Nearly all the species are new, and are mostly from localities whence no forms were before known. Littoral forms are remarkably deficient. Besides the species found by the Challenger, other new forms already in the British Museum are described. The report contains the first detailed outlines of the structure of the group yet given. The structure of the genera is described, and the forms of the zooids, as well as the number and proportion of the mesenteries, are detailed. Four of the species occurred between 2,000 and 3,000 fathoms. The Antipatharia approach the Cerianthidæ more than the Hexactiniæ in the arrangement of the mesenteries, and in the relatively thin mesoglea, devoid of stellate connective tissue cells, the rudimentary musculature of the mesenteries, etc. This report has 222 pages, and 15 plates.

Echinodermata.—J. Georg (*Archiv für Naturgeschichte*, Sept., 1889), gives reasons for the belief that the echini excavate their holes in the rocks not by any chemical solvent, but by their teeth. As they enter young, the bottom of the hole is larger than the entrance, and thus the tenants are prisoners, dependent for food upon such forms of life as are brought by the currents, such as foraminifera, etc. Though

the spines are not the prime agents in the excavating process, they aid the teeth by their rotary motion. It has been surmised by some that marine algæ, by their chemical action upon limestone, aid the urchins in the boring of their holes, but it cannot be found that algæ exert any such chemical influence, and urchins bore into sandstones, granite and lava as well as into limestones, so that there is no relation between algæ and urchin-holes. The principal object of the toothed urchins in thus excavating seems to be to find shelter from the violence of the waves. (See Fewkes, NATURALIST, Jan., 1890).

Mollusca : Annelida.—The Polyzoa collected in Japan by Dr. L. Döderlein are described in the *Archiv für Naturgeschichte*, of December, 1889, by Dr. A. Ortman, and the memoir is illustrated by four double plates.

Nos. 5 and 6 of the *Annals of Natural Sciences* (Zoöl., Vol. VII.), are occupied by M. Louis Roule's studies upon the development of the Annelida, and especially of *Enchytroedes marioni*, a new species of limicolous oligochoete. His results are somewhat startling, inasmuch as they induce him to place the mollusks and the annelids in the same group, called by him Trochozoaires. In both groups the cœlom is not a true enterocœle, since it is not derived from the archenteric diverticular, but is hollowed out, without direct relation with the archenteron, in the mass of cells that are produced by the initial mesoblastic segmentation. Moreover, both groups, as is sufficiently well-known, have similar larvæ, Trochospheres or Trochozoa. The chief difference is the polymerism of the one group and the monomerism of the other.

An immense squid, the long arms of which, although shrunk, measured 30 feet in length, and the body and short arms of which were 60 feet in circumference, was stranded in November last upon Achill Island, off the west coast of Mayo, Ireland. Some of the short arms measured four feet in circumference.

Arthropoda.—In the first and second numbers of the *Annals and Magazine of Natural History*, for 1889, M. E. L. Bouvier describes the nervous system of decapodous crustaceans, and the relations of that system to the circulatory system, giving particular attention to the Anomoura. The Caridida have an abdominal chain of six pairs of ganglia. In the Palinuridæ these pairs are completely fused transversely, but in the Astacidæ are less so. In the Galatheidæ there are still the same number of abdominal ganglia, but they are more concentrated longitudinally, and less so transversely. In the Paguridæ the longitudinal concentration increases, while the transverse union is

more remote than in the Galatheidæ. The Porcellanidæ, short though is their abdomen, have still five pairs of abdominal ganglia, while the Brachyura have the abdominal chain fused.

Dr. Walker and Dr. F. B. Mason enumerate nearly 100 species of insects in Iceland, about thirty of which are Coleoptera.

It is rather curious that not a single species of Lepidoptera has so far been discovered there. No Lepidoptera have as yet been seen upon Pitcairn's Island.

Ernst Lehrman (*Archiv für Naturgeschichte*, Sept., 1889), gives notes upon the anatomical structure of the Pentastomidæ. He treats of the body-covering, which is usually a chitinous skin, of the connective tissue, which is extraordinarily developed, of the musculature, of the nerve and sense organs, and also of those of digestion and sex.

Fishes.—It is not generally known that any of the Balistidæ have the power of producing sound. Prof. Moebius, however, has noted this peculiarity in *Balistes aculeatus*, and has recently described before the Berlin Physiological Society what he believes to be the apparatus producing it. During the drumming the skin between the clavicle and branchial arch vibrates, and the vibration seems to be caused by the motions of the post-claviculare, which forms a lever with a long and a short arm, the former of which is made to move by the action of the ventral muscles of the trunk. The short arm is thus made to move with noise on the rough inner surface of the clavicle. The swim-bladder, which lies very near, acts as a resonator.

There have lately been frequent reports of the presence of anchovies at Torquay and other southern coast fishing places, and this has been capped by the notice that they have also been found in Moray Frith.

Birds.—Many new species of birds from New Guinea and the Moluccas have been described by Hunstein Forbes and Woodford, during the last seven years, and thus the supplement to Salvadori's Accipitres, Psittaci, and Picariæ of these regions contains twelve new species of the first group, fourteen of the second, and nine of the third.

Mr. F. E. Beddard has, in a recent issue of the Proceedings of the Zoölogical Society, discoursed upon the structure of the Hornbills, especially that of the syrinx, and the muscular anatomy.

W. H. Hudson, in his Argentine Ornithology, gives an account of the manner in which *Polyborus tharus* singles out the white egret from

among a crowd of other birds, apparently for no other reason than because of its shining white plumage, and he asks, how has it been possible for the two white species of South American heron to escape their enemies and continue to exist?

Mammals.—*Nature* (Nov. 7) states that about 1829 some individuals of the buffalo (*Bos bubalus*) were landed at Port Essington, and that at the present time the increase of these specimens has resulted in the existence of immense herds in certain parts of North Australia.

The columns of *Nature* have recently contained quite a controversy upon the discovery of the existence of true teeth in the jaw of the young Ornithorhynchus. This discovery is claimed by Mr. Poulton, and the structure of the teeth has been described by Mr. Oldfield Thomas. The reference to the teeth of both the young and the adult Duck-bill in the works of Sir Everard Home is asserted to have been solely to the horny plates which eventually take the place of the true teeth, and to the changes that take place in them.

The last volume issued by the venerable cetologist, P. J. Van Beneden, restricts the number of European Cetacea to twenty-six, of which seven are whalebone whales, and five ziphioids.

In the *Quarterly Journal of the Microscopical Society* A. W. Hubrecht gives the results of his studies upon the placentation of the hedgehog. The phenomena of placentation are more complex than in the ungulates, and lead up directly to those exhibited by the primates and man. But as the Insectivora are now pretty generally regarded as the most primitive of the monadelphous mammals, this takes away the importance of the division into Deciduata and Adeciduata. The Ungulata are certainly adeciduate, but among the Edentata some genera are deciduate and others adeciduate: the lemurs are also non-deciduate.

PSYCHOLOGY.

The American Society for Psychical Research—Is a thing of the past. It was disbanded as a separate organization when its fifth and last annual meeting was held in the lecture room of the Boston Society of Natural History, and it became a branch of the English society. Prof. William James presided at the meeting, which was attended by about 200 members and associate members and their friends. Secretary Hodgson read the records of the last meeting, the certificate of the auditors that the financial statement for the year ending in 1889 was correct, and the report of the treasurer for the year just closed. By the latter it appeared that the receipts were $3898, the expenses $3542, and the balance on hand $356. Mr. W. L. Parker and Dr. Morton Prince were appointed to audit this account.

Dr. E. G. Gardiner was then called upon by the president to give the views of the council of administration in regard to a proposition that the American society become a branch of the English organization. He said that the council found, some time ago, that the society was not receiving a sufficient amount of funds to properly carry on its work of psychical research. The members were asked if they would submit to an increase in their dues; but few of them agreed to this, and though a number of donations were received from friends, their sum was not large enough for the needs of the society. At this juncture the council communicated with the English society, which offered to form a branch in this country, of which any member or associate member of the American organization might become a member on the payment of annual dues amounting to $3. The English members are required to pay $5 per annum, but these in this country would have all the privileges of those in England, except that of voting, and would get copies of all the publications of the society, including the monthly journal and the annual proceedings. It was the desire of English society to retain the American secretary, and it had guaranteed his salary for one year, but it would have to receive financial aid from America to continue employing him after the expiration of that time. Three American vice-presidents—Prof. S. P. Langley of the Smithsonian Institute, Prof. William James of Cambridge, and Prof. H. P. Bowditch of the Harvard Medical School—have already been elected, and they would form an advisory board for this country.

Dr. Gardiner said there seemed to be no choice but to disband, for the society did not have the money to go on. It would cost less to maintain a branch of the English society than it would to support a

separate organization. The English society thought it could carry on psychical work in this country, where the American society had failed, and he moved that the latter be abandoned and be made a branch of the English organization.

Mr. Samuel H. Scudder spoke in favor of the proposition, seconding Dr. Gardiner's motion, as did also Prof. James, who briefly reviewed the history of the society. He said he had little hope of its success from the start, for few joined it who had given special attention to psychical research, although many of the members occupied prominent positions in other branches of science. So the work had been done almost entirely by the secretary. There had been a formal organization, with but few workers to back it up, and the organization had been a hindrance, rather than a help, to investigators, who could accomplish more if they were responsible directly to the English society.

The question was then put to vote, and it was carried unanimously. Only nine votes were cast, however, as that was the number of active members, who alone are entitled to vote, present at the meeting. The secretary stated to a *Herald* man that there are 400 members of the society, fully three-quarters of whom will become members of the English society.

The meeting was continued as a session of the new organization, Prof. James remaining in the chair as vice-president of the English organization. He described his visit to the leaders of the English society and the psychical congress in Paris last summer. He came away, he said, with great respect for the work that is being done in Europe, and he was struck with the respect in which it is held by all classes of intelligent people there. He spoke of the international census of hallucinations now in progress in England, France, Germany, and America, which is under his charge in this country, and he dwelt, at length, on some of the wonderful investigations that have been made by M. Pierre Janet, of France, and others.

On the circulars calling the meeting it had been announced that Secretary Hodgson would read a paper by Mr. Frank Podmore, of the English Society for Psychical Research, on "Phantasms of the Dead," but he stated that Mr. Podmore's paper had not been received, and instead, he read statements of some of the recent cases which he collected. Among them were some truly weird and remarkable narratives of dreams and presentiments, and several cases were given where people had saved themselves from bodily harm by obeying unaccountable impulses.

ARCHÆOLOGY AND ETHNOLOGY.

Prehistoric Occupation in Cambodia. — Shell-heaps in Asia.—Polished Stone Implements in the National Museum. —The principal river of Cambodia is the Me-Kong. Its source is far up in the mountains of Thibet, where it has the name of Lam-Thsang-Kiang. It traverses the Chinese province of Yum-Nan, and those of Laos and Cambodia, and enters the China Sea in the French province of the latter name, in latitude 10 degrees north, longitude 106 degrees and 40 minutes east. Its average width through Cambodia is 3,500 to 4,000 feet. In its lower portion it divides itself many times and forms a network of navigable waters, and finally discharges itself through eight mouths.

The present capital of the province is Phnom-Penh, situated on the Me-Kong, about one hundred and seventy-five miles from its mouth. At the city of Phnom-Penh the river Me-Kong forks. It is the western fork with which this account deals. The eastern branch is the main river; the western branch is but a blind stream which, after the fashion of a bayou, is fed from the main river. Its length is one hundred and seventy-five miles, and it ends in an immense lake eighty or ninety miles in length called Ton-le-Sap.

Each year the Me-Kong river, by reason of the melting of the snows in the mountains of the central plateaux of Thibet, overflows and inundates the lower country which it traverses. The level of the lake Ton-le-Sap is about thirty-six feet lower than that of the Me-Kong river at Phnom-Penh where the bayou joins the river. The period of inundation is the months of July, August and September, and at their beginning the waters from the river fill the bayou, run northward through its length, and empty in and fill the lake. During the inundation the water in the lake attains a depth of thirty-five or forty feet, and, consequently, spreads over a vast extent of the country which before was uncovered. On the termination of the flood and the subsidence of the water in the river, the current in the bayou is reversed; it runs south, empties into the river, and so drains the lake. During the dry period, which lasts six months of the year, Ton-le-Sap, instead of being a great lake of water, is a plain of soft mud.

The action of the water in this river and lake is similar to that of the Nile and the lake Moeris in Egypt. It is easy, with the illustration of the Nile, to understand the operation, and also the quantity of

alluvial soil which would be deposited each year in the lake Ton-le-Sap, likewise the numerous changes made in the shores of the lake during the ages this operation has been going on.

On the retreat of the waters, the shores of the lake and little islands in it become dry. The people from the neighboring highlands come down, occupy these spots, and there appear flourishing villages, which are to last, however, only six months of the year, when they will be submerged by the next year's inundation, the inhabitants being driven to the highlands for safety.

The geographic and hydrographic details being understood, we may now explain the prehistoric stations of the neighborhood. Not far distant from the border of this great lake there have been found numerous and vast Kjoekenmoeddings, or shell-heaps, many of which have been excavated by the natives to obtain the material for fabrication of lime. It was from these shell-heaps that Mr. Jammes obtained the stone implements which have lately come into the possession of the National Museum. He discovered eighteen of these shell-heap stations, and excavated some of them. They are covered by a stratum of alluvial soil, the deposit of the floods. The depths or thicknesses of the shell-heaps were from thirteen to twenty-nine feet. They were composed of three layers quite distinct from each other, and each bearing evidence of a different civilization and an occupation by a different set of men. They were as follows, commencing at the top:

The first stratum had the least thickness. In it were instruments of copper, though possibly some of bronze—hatchets, pins, bracelets, etc. There were pieces of stone finely worked. The pottery was of the most perfect form, and some of it was ornamented with the ordinary designs of the bronze age.

In the second stratum were objects in stone mixed with those of the bronze or copper, and this is considered to mark an epoch of transition between the bronze age and the stone age which formed the lower stratum.

This lower stratum was the deepest of the three, and here were found the implements and pottery which belonged to the age of polished stone.

These shell-heaps have required a long period of time. Some of them were distant more than fifty miles from the great lake, and it is supposed that at their epoch they were on the borders of the lake thus extended. In the lake of Ton-le-Sap are now found several species of the same shells and mollusks as those of the prehistoric stations, but the latter are thicker and heavier. It is certain from this and other discoveries that the period of the polished stone age is very ancient

in Indo-China, possibly of higher antiquity than the same age in Europe, though there has, as yet, been no synchronism established between them. It is now more than 2,000 years since the Khmers, of whom the Cambodians pretend to be the descendants, constructed temples and palaces which were of sufficient dignity to have belonged to the antiquity of Egypt. These are all in ruins, yet the voyager can still see enough to show them in their gigantic and barbaric splendor. The temple of Ang-Kor-What, of which Mr. Jammes has made an attempt at restoration, is not less than 3,900 feet in the length of its principal façade, by one hundred and sixty or one hundred and seventy feet in height. It was built of cut stone and is ornamented everywhere with superb sculptures and bas-reliefs. To-day these imposing ruins are invaded by a tropical vegetation that has covered and suffocated them in its embrace. On the ruined and fallen towers, or in the earth about them, enormous trees now grow, and sometimes portions of the wall, windows or doors are sustained and supported by the roots of the great banian trees.

Anthropology demonstrates that the men of the epoch of polished stone were the ancestors of the constructors of the great temples in the Orient, though they were then in full possession of iron, silver and gold. How many centuries of this rude civilization was required to traverse the space between the polished stone age when these shell-heaps were made, and in which its objects and implements were lost or deposited, until the brilliant period of the temple of Ang-Kor-What?

The anthropological side of this subject has not yet been studied. We are in ignorance of the facts, and are without sufficient knowledge to be able to even approximate this great progression. Mr. Jammes found several skeletons in his excavations of these shell-heaps. He calls the people the race of Som-rong-sen, after the name of the principal shell-heap. The people of the race he remarked as being of large proportion, great height, and vigor. Some of the skeletons were, as he reports, more than two metres in height. What seemed to astonish him more than anything else was the thickness of the skull, which sometimes attained twelve millemetres in the occipital region.

The men of these shell-heaps buried their dead in their habitations. The care that they took in the position of the skeletons is a slight evidence of their belief in a future life. Near the bodies were frequently placed various implements of their industry. Pieces of pottery were found filled with the débris of food.

This civilization belongs to a prehistoric race, and corresponds with a mixture of the polished stone and bronze ages in western Europe.

The objects found were some of them similar; others only analogous. The polished stone hatchets, and similar implements, were the most numerous. They were not nearly so well made nor so complete as those from other countries. The material is usually a fine, hard, compact and siliceous schist, sometimes yellow or gray, other times black, frequently made of a pebble with remains of its original crust apparent. Some of them would indicate a new method of handling, for they have a straight stem or tang, as large square as the thickness of the hatchet, and which is cut down at the edges so as to make shoulders. The tool most plenteous is the adze. Its sharpening is all done from one side. Gouges are found, though not so common. They are made in the same way as were the adzes, except that the edge is polished. Objects of shell are frequent; bracelets, rings, and beads are made of this material. It also served for scrapers and cutting implements. Objects of bronze were not found, but those of copper were.

Mr. Jammes is Director of the Royal School of Cambodia at Phnom-Penh, and he displayed his collection at the International Congress of Anthropology and Prehistoric Archæology held at Paris last summer.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

The American Geological Society.—At its late meeting in New York, December 26-28, the following papers were presented (Continued from the NATURALIST, February, 1890, page 212.):

ON THE TERTIARY DEPOSITS OF THE CAPE FEAR RIVER REGION. William B. Clark, Baltimore, Md.—The Eocene occupies small detached basins within the Cretaceous, while the Miocene extends widely over Eocene and Cretaceous alike.

Post-Cretaceous erosion left an irregular surface over which the older Tertiary deposits were scattered. Post-Eocene erosion approximately base-leveled this surface, leaving the early Tertiary sediments preserved in the deeper Post-Cretaceous depressions. Upon this base-leveled surface the Miocene strata were laid down.

An intermingling of numerous characteristic Cretaceous species with Eocene forms was observed at several places; likewise of *Exogyra costata* hiwt Miocene types.

CRETACEOUS PLANTS FROM MARTHA'S VINEYARD. C. D. White, Washington, D. C.—The topics treated in this paper are: Review of

opinions respecting the age of the Vineyard series; plants found at various localities in that series; the Gay Head flora cretaceous; its distribution and affinities; mode of occurrence; eastward extension of the Middle Cretaceous; origin of amber in the Vineyard. Illustrated.

THE GEOLOGY OF THE CRAZY MOUNTAINS, MONTANA. J. E. Wolff, Cambridge, Mass.—This paper describes the structure of these mountains, which are composed of Cretaceous strata, horizontal or but gently inclined, cut by numerous narrow vertical dikes and large irregular masses, as well as great bulging intrusive sheets of laccolites, which have been tilted with the strata. Brief descriptions are given of the eruptive rocks and of the contact metamorphism produced by them.

THE CUBOIDES ZONE AND ITS FAUNA. A DISCUSSION OF METHODS OF CORRELATION. H. S. Williams, Ithaca, N. Y.—In this paper, after discussion of the principles of correlation, and after comparisons of fauna of this zone in Europe and Asia, as well as in America, the author comes to these conclusions:

That the fauna of the Tully limestone of New York is the representative of the fauna of the Cuboides zone of Europe homotaxially; that the relations of the two faunas may be best explained by the hypothesis that the fauna of the Tully limestone is not a direct sequent of the underlying Hamilton fauna alone, but in its characteristic species shows evidence of community with European faunas to be explained by migration.

A comparison of all the related faunas at present known leads to the conclusion that the Cuboides and Tully faunas are not only homotaxial but relatively contemporaneous, the margin of difference in the time of the existence of the two faunas probably not greater than the period of existence of the Cuboides fauna in its typical localities in Europe.

THE INTERNAL RELATIONS AND TAXONOMY OF THE ARCHÆAN OF CENTRAL CANADA. Andrew C. Lawson, Ottawa, Canada.—Archæan comprises two great systems, Lower (Laurentian), composed of plutonic igneous rocks; Upper, of indubitably normal surface rocks, variously altered. Lower, irruptive through Upper and of younger age, piercing the latter, holding detached fragments from its shattered margin, and inducing contact metamorphism. Conception of Archæan suggested by the facts: Its ideal simplicity; complications; combined effect of plutonic irruptions and crust-crumbling forces. Geognostical equivalents of Laurentian elsewhere found to be eruptive.

THE CRYSTALLINE SCHISTS OF THE BLACK HILLS OF DAKOTA. C. R. Van Hise, Madison, Wisconsin.—A review of the distribution of the slates, schists, and granites is given as mapped by Newton. Cross lamination, and the arrangement of pebbles in the conglomerates, show that the real thickness of the slates is independent of their apparent thickness as measured by cleavage. The largest area of crystalline schist is a belt surrounding the granite mass in the southern part of the pre-Cambrian area. It always strikes parallel to and dips away from the granite. The structure is then here laccolitic. The granite, by its contact and dynamic action, produced these crystalline schists. The evidences of fragmental origin in clastic rocks is generally retained when subject to pressure only, however great the pressure. The evidences of fragmental origin in clastic rocks is rapidly obliterated when they have been subject to dynamic action. Illustrations: The original detritus of the Black Hills mica-schist was feld sparand quartz. By a decomposition of the former, producing mica and quartz, and a breaking down of the larger particles of the latter by dynamic action, coarse, even granular, completely crystalline mica schists have been extensively produced. Different degrees of crystalline character are seen in the field, and various stages of the change are traced out in thin section. The paper then speaks of the age of the slates, schists, and granites.

SOME RESULTS OF ARCHEAN STUDIES. By Alexander Winchell, Ann Arbor, Mich.—This memoir is a condensed statement of observations made by the author in northern Minnesota and contiguous regions. With these are incorporated some records of other observers in the same field. Being simply a report of facts observed, the memoir is calculated to stimulate inquiry rather than provoke discussion. The field is thought to be one of such comparative simplicity of structure as to promise a much easier solution of the Archean problem than any of the complicated regions of New England and eastern Canada. Several systems of rocks are enumerated in succession, distinguished by structural relations, and lithological and mineralogical contrasts. These are, in descending order: V. The uncrystalline schists (Animike); IV. The sub-crystalline schists (Kewatin of Lawson); III. The crystalline schists (Vermilion of N. H. Winchell); II. The gneissoid rocks; I. The granitoid rocks (not fundamentally distinct from the gneissoid). The oldest four of these systems exhibit an unexpected stratigraphical conformity with each other, and a stratigraphical and mineralogical intergradation, which seems to unite them in closer

historic continuity than could be admitted on the consideration of their enormous volumes, their disparity of age, and their widely contrasted lithological facies. The fifth system is shown to lie in wide structural discordance with the older ones, and to be in every respect impossible of identification with the IVth system, with which Irving confounded it under the designation "Huronian." The four oldest systems are geographically and structurally distributed over a number of oval or irregular areas, each revealing granitoid rocks in the centre, and gneissoid rocks and crystalline schists in successive concentric bands, with the subcrystalline schists filling the intervals between the crystalline schists of neighboring areas. The granitoid and gneissoid centres appear to have been protruded, and crowded mutually upon each other, until the intervening subcrystalline strata have been thrown into closely folded synclinal attitudes. These schists, consequently, are vertical in position, and the crystalline schists and gneisses succeed them in close parallelism. Toward the centre of each area, the gneisses, even while maintaining their verticality, sustain anticlinal relations to each other. But sometimes, in approaching the centre, a dip towards the periphery supervenes, and this diminishes to horizontality. The centre of the area is not always occupied by granitic rocks. In some cases, they are strictly gneissoid. The state of the facts may be easily comprehended by conceiving all the systems originally in a horizontal position, and conformably superposed in the order indicated—then an up-swelling in places, which, with shrinkage of the terrestrial crust, would crowd the higher beds into interareal synclinal olds as we find them.

Thus, if we had only the geology of the Northwest to settle, the Archean question would be simple. Older observations in more difficult regions have created questions of correlation which the canons of science require us to answer. But these and other questions of a speculative character are postponed to future occasions.

ORIGIN OF THE ROCK-PRESSURE OF NATURAL GAS IN THE TRENTON LIMESTONE OF OHIO AND INDIANA. Edward Orton, Columbus, Ohio. —In this paper the author defines the term rock-pressure: shows the decrease in rate westward: discusses theories of origin already offered: presents facts supporting the theory of hydrostatic origin: offers conclusions respecting duration of gas-supply in Ohio.

ON POT-HOLES NORTH OF LAKE SUPERIOR UNCONNECTED WITH EXISTING STREAMS. Peter McKellar, Fort William, Ontario.—This paper deals with some large and remarkable "Kettles" or "pot-holes"

some distance back from the Lake, and at a considerable elevation above the present level. They must have been produced by a very swift current of large volume, yet there is no existing stream near them. The direction of the torrent is examined. The well-marked high terraces of the north shore of Lake Superior are considered in this connection, also the lines of depression through the low water-shed between Lake Superior and Hudson's Bay.

On the Pleistocene Flora of Canada. Sir William Dawson and D. P. Penhallow, Montreal, Canada.—The Pleistocene deposits of Canada were defined as consisting of three principal members.

First.—The Till or Lower Boulder Clay, containing local and traveled stones and boulders, often glaciated and resting on glaciated surfaces. In the more maritime regions, *e. g.*, the lower St. Lawrence, it contains marine shells of arctic species. Further inland, *e. g.*, in Western Ontario and the plains west of Red River, it is not known to hold marine remains.

Secondly.—Stratified clays and sandy clays which in the more maritime and lower regions are the "Lower and Upper Leda Clays," holding many maritime shells and drift plants, etc., indicating neighboring land. In the interior they hold more abundant vegetable remains and locally beds of peat, and also fresh-water shells. These beds have been known as "Interglaciæ."

Thirdly.—Sands, clays, and gravels, often stratified, sometimes containing traveled boulders throughout; in other cases having boulders below and above. These beds in the maritime region contain sea-shells; further inland they are unfossiliferous. They constitute a second or newer boulder formation, and their traveled boulders are often of large size, and found at greater elevations than that of the lower boulder clay.

Above these are alluvial deposits, lakes, terraces, gravels, and eskers-prairie-silt, peat deposits, etc., which may be regarded as modern, or post-glacial.

The plants referred to are contained principally in the second formal tion, but when, as sometimes happens, this is absent, drift vegetable fragments are found in the boulder clay.

The phenomena point to extensive changes of level and climate going on throughout the pleistocene, in which, while the high lands were occupied with snow and glaciers, and the submerged plains and valleys were filled with floating ice, there were throughout, and especially in the central period, oases occupied with vegetation, in the

manner so well explained by Fielden as now occurring within the Arctic circle.

The plants procured had in part been described and figured in papers published by Sir W. Dawson in the Canadian *Naturalist.* They constitute a cold, temperate, or boreal flora, composed of species still living in the region of the Lawrence and its lakes, and northward. Professor Penhallow has kindly undertaken to review the material previously described, and to examine a number of specimens recently obtained, and presents a detailed list and notes of the forms described.

Boston Society of Natural History.—December 4, 1889, Dr. R. T. Jackson discussed certain points in the development of the Mollusca. Dr. J. Walter Fewkes described a remarkable instance of rock excavation by Sea-Urchins.

December 18, Dr. Frederick Tuckerman read a paper on the "Gustatory Organs of Mammals." Mr. S. H. Scudder made a few remarks on fossil plant-lice.

January 1, 1890, there was a discussion of "The Climatic Conditions of the Glacial Period."

February 5th, Prof. F. W. Putnam spoke on "Early Man in America," and brought forward some new evidence of the contemporaneity of man with the mastodon. Mr. S. H. Scudder made a few remarks on a small collection of beetles from the inter-glacial clays of Scarboro', Ontario.

February 19th, Mr. Samuel Garman read a paper on "Some Recent Discoveries in Caves." Prof. W. O. Crosby spoke on "A Large Granite Bowlder in Madison, New Hampshire," and on "The Occurrence of Decomposed Granite in Blandford, Massachusetts."

March 5th, Prof. W. O. Crosby called attention to an "Interesting Occurrence of Decomposed Granite in Blandford, Massachusetts." Dr. J. Walter Fewkes read a paper on "Some Rare Marine Animals from California."—J. WALTER FEWKES, *Secretary.*

New York Academy of Sciences.—March 10, 1890, the following paper was read: "On Geographical Variations in the Horned Larks of North America," by Jonathan Dwight, Jr.—H. CARRINGTON BOLTON, *Secretary.*

Chicago Academy of Sciences.—March 11th, Maj. Gen. Geo. Crook, U. S. A., held a conversazione. Subject: "The Mode of Warfare, Life, and Character of the American Indians."—C. E. WEBSTER, *Recorder.*

The Chicago Institute for Instruction in Letters, Morals and Religion.—A course of lectures on the testimony of science to evolution has been held in Rehearsal Hall, in the new Auditorium Building, as follows:

November 22, Prof. E. W. Claypole, D. Sc., F. G. S., Akron, Ohio, "The Development and Destiny of the Earth."

December 6, Prof. T. J. Burrill, Ph.D. (University of Illinois), "Lessons from Leaves, Flowers and Fruits."

December 20, Pres. David Starr Jordan (University of Indiana), "Evolution and the Distribution of Animals."

January 3, Prof. Alexander Winchell (University of Michigan), "The Paleontological Evidences of Evolution."

January 17, Prof. W. K. Brooks (Johns Hopkins University), "Embryology and Evolution."

February 7, Prof. Edward S. Morse (Director Peabody Academy of Science, Salem), "Variation and Inheritance as Factors of Natural Selection."

February 21, Prof. S. A. Forbes (University of Illinois), "Entomological Illustrations of Evolution."

March 7, Prof. E. D. Cope (University of Pennsylvania), "Causes and Agencies of Evolution."

March 13, Prof. John Fiske (Cambridge, Mass.), "The Doctrine of Evolution; its scope and influence."

Proceedings of the Natural Science Association of Staten Island.—December 12, 1889. Meeting called to order at 8.20 o'clock. A paper on the Carabidæ of Staten Island, by Mr. Charles W. Leng, was read by the corresponding secretary.

The corresponding secretary read by title a paper by Mr. William T. Davis, upon the homestead graves of the island, which will be issued as a special number of the proceedings.

Mr. Joseph Thompson showed *Cecropia* cocoons which had been eaten by field mice.

Mr. Arthur Hollick showed specimens of wheat in which the grains had all sprouted while in the ear. The specimens were from stacks in a field on the Vanderbilt farm at New Dorp. The grain in all the stacks was in the same condition—due to the phenomenal wet season.

Adjourned at 9.45 o'clock.

February 13, 1890. Amongst the various communications read was one from a prominent resident of the island, offering to donate half an acre of land for the building. The secretary was not, however,

authorized to make public the donor's name. Attention was also called to the many favorable notices of the enterprise in the local papers and elsewhere.

The old milestone, formerly standing at the junction of Signs Road and Richmond Turnpike, was on exhibition, having been secured by the association since the last meeting. This was supposed to be the last one remaining on the old post route between New York and Philadelphia, or at least upon that portion of it which crossed Staten Island. The stone is considerably the worse for wear, the upper part having been chipped off, possibly for momentos, thus destroying part of the inscription, which now reads:

Miles
to
N. YorkE

The figures denoting the distance were doubtless upon the part which was chipped away. This old and interesting relic of bygone times has been secured none too soon, and the association is to be congratulated upon having secured and placed it where it will be safe from further danger. In this connection Mr. Arthur Hollick stated that at some future meeting it was expected that a paper upon the subject would be presented, and then read the following brief abstract from Clute's History of Staten Island:

"After Governer Tompkins had laid out and opened the Richmond Turnpike stages ran regularly over the whole length of the new road, in connection with steamboats from New York, and constituted part of the route of travel between New York and Philadelphia. At the western terminus of the Turnpike stages were carried over the sound by means of large scows, and this ferry received the name of the 'New Blazing Star.'"

A mummified rat was shown, presented by Mr. Daniel Campbell. The animal had contrived to force its way into an angle between a beam and the cellar wall of a dwelling in New Brighton, and for some reason had been unable to extricate itself. The remains were thoroughly dessicated and excellently preserved.

Mr. E. M. Eadie presented a large piece of drift rock from Old Place, probably Oriskany sandstone, containing *Spirifer arrectus*.

Biological Society of Washington.—October 19, 1889, the following communications were read: Dr. C. Hart Merriam, "Description of a new Spermophile from the Painted Desert, Arizona;" Mr. Theo. Holm, "The Ancestors of *Liriodendron tulipifera*;" Mr. Theo. Gill, "On the Dactylopteroidea."

November 2, 1889, the following communications were read: Prof. C. V. Riley, "The Remarkable Increase of *Vedolia cardinalis* in California;" Mr. W. H. Dall, "Notes on the Genus *Gemma* Deshayes;" Dr. George Marx, "On a new Spider and its Influence on Classification;" Dr. C. Hart Merriam, "Remarks on the Spotted Skunks (Genus *Spilogale*) with Descriptions of New Forms."

November 30, 1889, the following communications were read: Dr. Theobald Smith, "Preliminary Observations on the Micro-organisms of Texas Fever;" Dr. D. E. Salmon, "General Remarks on Texas Fever, illustrated by Lantern Slides;" Mr. C. D. Walcott, "Description of a New Genus and Species of Inarticulate Brachiopod from the Trenton Limestone;" Dr. Frank Baker, "An Undescribed Muscle of the Infraclavicular Region in Man."

December 14, 1889, the following communications were read: Dr. C. Hart Merriam, "Results of a Biological Survey of the San Francisco Mountain Region in Arizona;" Mr. C. D. Walcott, "A New Genus and Species of Ostracod Crustacean from the Lower Cambrian;" Dr. A. F. A. King, "On the Flight of Young Birds."

December 28, 1889, the following communications were read: Dr. A. F. A. King, "On the Flight of Young Birds;" Mr. M. B. Waite, "On the Method by which the Seeds are Projected in *Pilea pumila*;" Dr. C. Hart Merriam, "A New Red-backed Moose (*Evotomys*) from Colorado;" Mr. Theodore Holm, "Generic Characters of *Gramineæ* and *Cyperaceæ*, taken from the Structure of the Leaves."

February 8, 1890, the following communications were read: Dr. Frank Baker, "An Undescribed Muscle from the Infraclavicular Region of Man;" Mr. C. D. Walcott, "A New Genus and Species of Ostracod Crustacean from the Lower Cambrian;" Dr. Cooper Curtice, "The Moultings of the Cattle Tick;" Prof. Lester F. Ward, "The Flowers that Bloom in the Winter Time."

March 8, 1890, the following communications were read: Mr. B. T. Galloway, "Notes on a Fungous Disease of the Apple;" Mr. C. L. Hopkins, "Animal Life Observed above Snow Line on Mt. Shasta," "Notes upon the Timber and Timber Line of Mt. Shasta;" Mr. W. H. Dall, "On Dynamic Influences in Evolution."—FREDERIC A. LUCAS, *Secretary*.

SCIENTIFIC NEWS.

A Review of the Charges Against the Paleontological Department of the U. S. Geological Survey, and of the Defence made by Prof. O. C. Marsh.

To the Editor of the NATURALIST:—"I am glad that the matter has at last come out. It will clear the atmosphere. The truth will be sifted out from the falsehood, and great good will be accomplished." This was the answer given by Prof. H. F. Osborn, of Princeton, to a *N. Y. Herald* correspondent, when asked for his opinion about the Cope-Marsh controversy. I fully agree with Prof. Osborn in these remarks.

I will now give a short review of the charges made against Professor Marsh, and of his defence, based on an experience of nearly six years, during which I was an assistant of Prof. Marsh, paid by the U. S. Geological Survey.

1. In the New York *Herald* of January 12th, Prof. E. D. Cope, of the University of Pennsylvania, stated, "The collections made by Prof. Marsh, as the vertebrate palæontologist of the Geological Survey, . . . are all stored at Yale College, with no assured record as to what belongs to the Government and what to the College."

To this Professor Marsh replied that "every specimen belonging to the government is kept by itself, and no mixing with the Yale Museum collections is possible." Prof. H. F. Osborn and Dr. O. Meyer have sustained this fully, and I am glad to say that great care is taken at the Yale Museum in this regard. But this is irrelevant to the question raised by Prof. Cope, for, of course, the labeling is entirely in the hands of Prof. Marsh, without any control from the Geological Survey. In this connection there is one thing that I can not quite understand; how it is that the splendid specimens of horned dinosaurs became the property of Prof. Marsh, and not of the government. Can Prof. Marsh pay his collectors this month out of his own pocket, and the following out of the pocket of the government?

2. The next statement made in the *Herald* is, that these collections "are locked away from the people, and no one is allowed to see them, not even visiting scientists." This Prof. Marsh admits is in part true.

He says, that "visiting scientists of good moral character are always welcome." Now I may mention, that a scientist of very "good moral

character," well known in this country and in Europe, wanted to see the material of the Dinocerata shortly after the volume on this order had been published. When he arrived at New Haven he was told by Prof. Marsh that he was very sorry not to be able to show him the material, since it had been boxed up lately and was inaccessible. The fact is, that the whole material was spread on a large table in the room where the conversation took place. By the order of the professor the fossils had been covered up with cloth the day before.

3. The next charge of Prof. Cope is, that the greater part of Prof. Marsh's published work has been done by his assistants. This is denied by Prof. Marsh emphatically. As it is a very important question, I shall try to solve it as far as I am able to do. I can not speak of the authorship of the work on the Odontornithes from personal knowledge, but from all that I have heard at New Haven it is true that this memoir is mainly the work of the late O. Harger. Mr. G. B. Grinnell, in a letter written to Prof. Marsh and published in the *Herald*, stated that Prof. Marsh dictated to him a part of the description and all the conclusions of the work. This is all true, but the question remains, *From whom did Prof. Marsh receive that which he dictated* to Mr. Grinnell? I think it is now the proper place to speak a little more fully as to the way of using his assistants adopted by Prof. Marsh. The fact is that a great part of the descriptive and general part of most of Prof. Marsh's papers is the work of his assistants. Prof. Marsh asks them questions, the answers of which he either immediately puts down in black and white, or he makes out a list of questions to be worked out by his assistants, for instance: "What are the principal characters of the skull of the Sauropoda?" or, "What are the relations between the different groups of Dinosaurs?" and so on. The assistant, if not yet fully familiar with these questions, begins to work; he goes over the whole literature, a thing rarely done by the Professor, and studies the specimens in the collection. After this is done, the Professor receives the notes of the assistant, or he asks questions, writing down the answers he receives. In this way he accumulates a great quantity of notes, written in his own handwriting, or in that of the assistant. By comparing and using these notes it is easy for him to dictate a paper to any person who can write. This person, of course, when asked, can testify that the work was dictated by Prof. Marsh, without telling a falsehood.

Since I have been named in connection with the work of the Dinocerata, I may state here fully the nature of the assistance I rendered in its preparation. On two Sundays I spent a number of hours at

Prof. Marsh's house, to "go over his conclusions." Questions were asked and answered, new points were brought up by me and adopted, and when it came to the classification of Ungulata, I gave my opinion, which was mainly based on Prof. Cope's work, introducing small changes only. I gave the classification with Prof. Cope's names, as I informed him; but these were all changed by Prof. Marsh. There is no doubt Prof. Marsh had never studied Prof. Cope's papers on this subject, since he not only did not know the names of the orders, but he even asked how to spell them. That the descriptive part of the Dinocerata was mainly the work of Mr. O. Harger, I know. He made both descriptions and measurements of the different bones, which were used by Prof. Marsh when he wrote his text, or dictated it. It may be here a proper place to mention the language used by Prof. S. E. Smith, of Yale University, in an obituary of Mr. Harger, his best friend. "His best work and highest attainments were in the department of vertebrate palæontology. Remarkable logical powers, an unbiased mind, and years of accurate observation, had given him a truly wonderful knowledge of vertebrata osteology. Under his hand the broken and disarranged bones of an unknown carpus or tarsus seemed to fall into their proper places by magic. But his knowledge was not one of details alone; he had a truly philosophical grasp of the bearing of facts on evolution and classification, and *only the few who knew his attainments can appreciate how much palæontological science* would have been advanced *had he been able to publish his observations and conclusions.*" (Italics are mine.) I may mention here, that the statements of Dr. O. Meyer in regard to the Batrachia and Mammals from the Jurassic, and the oldest "bird" *Laopteryx*, are true.

Now let us consider some papers of Prof. Marsh which were doubtless written by himself. There is one on the Cretaceous Mammals. In this paper several times over three or four genera are made out of three or four teeth belonging to animals of one genus. Incisor, molar and premolar teeth of the upper and lower jaw are considered to belong to three or four different animals; each representing a new genus. The discovery of Cretaceous mammals in great numbers (only one species was known before, which was found by Dr. J. L. Wortman, Prof. Cope's former assistant) of course was a very interesting fact, and it is certainly this fact which induced Prof. Flower and Prof. Gaudry to write complimentary letters to Prof. Marsh. But the latter discovery is due entirely to Mr. J. B. Hatcher and Dr. C. E. Beecher. The description given by Prof. Marsh of these fragmentary, but highly interesting, fossils is simply ridiculous, and has been already criticised

by Prof. Cope and Mr. Lydekker, of the British Museum. Among other cases of the kind, I may mention only two, of one of which Dr. O. Meyer has already written. In 1877 Prof. Marsh described a new mammal under the name of *Apatodon mirus*, from the Jurassic of the Rocky Mountains, with the following words: "One of the most interesting specimens hitherto found in the Rocky Mountain region, is a portion of a lower jaw with the last molar in place. This fossil is widely different from anything yet discribed, and its exact affinities are doubtful. The fragment pertained to an animal about as large as a Tapir, and the general appearance of the specimen at once suggests the mammalian type. The tooth most resembles, in form and superior surface of crown, that of a typical suilline. The structure of the tooth, however, is different, and the fangs are, in part at least, coössified with the jaw.

"This specimen was found near a locality where Dinosaur bones were abundant, and it is possible it may belong with that gronp. The jaw, however, is very unlike any corresponding jaw of a Dinosaur, so far as now known. The geological horizon is Lower Cretaceous or Jurassic."

This was certainly a most interesting discovery. A mammal as big as a Tapir, from a Jurassic or Cretaceous formation, from which only very small Marsupial-like mammals were known, a mammal with teeth like a typical suilline from such an old formation, a mammal with the teeth partially coossified with the jaws, is something startling new! I had the greatest curiosity to see this specimen, and fortunately my curiosity was gratified. The hog-jaw from the Cretaceous or Jurassic was a weathered piece of a Dinosaurian vertebra, from the neural spine, some parts of which looked something like a tooth of a hog. Prof. Marsh knew of this mistake long ago, but he has not found it necessary to correct it. Only in his list of genera printed for private use, this specimen appears as a genus of Dinosaurs.

Another example. In 1884 the palæontological world was aroused by the highly important discovery by Prof. Marsh of a Dinosaur which was said to have the metatarsals united, just as a bird. The metatarsus of this reptile, called *Ceratosaurus* by Prof. Marsh, was figured side by side with the corresponding bone of a penguin, and at the end of the paper the following sentence occurs: "All known adult birds, living and extinct, with possibly the single exception of archeopterx, have the tarsal bones firmly united, while all the Dinosauria, except Ceratosaurus have these bones separable. This exception in each case brings the two classes near together at this point, and

Prof. Marsh's house, to "go over his conclusions." Questions were asked and answered, new points were brought up by me and adopted, and when it came to the classification of Ungulata, I gave my opinion, which was mainly based on Prof. Cope's work, introducing small changes only. I gave the classification with Prof. Cope's names, as I informed him; but these were all changed by Prof. Marsh. There is no doubt Prof. Marsh had never studied Prof. Cope's papers on this subject, since he not only did not know the names of the orders, but he even asked how to spell them. That the descriptive part of the Dinocerata was mainly the work of Mr. O. Harger, I know. He made both descriptions and measurements of the different bones, which were used by Prof. Marsh when he wrote his text, or dictated it. It may be here a proper place to mention the language used by Prof. S. E. Smith, of Yale University, in an obituary of Mr. Harger, his best friend. "His best work and highest attainments were in the department of vertebrate palæontology. Remarkable logical powers, an unbiased mind, and years of accurate observation, had given him a truly wonderful knowledge of vertebrata osteology. Under his hand the broken and disarranged bones of an unknown carpus or tarsus seemed to fall into their proper places by magic. But his knowledge was not one of details alone; he had a truly philosophical grasp of the bearing of facts on evolution and classification, and *only the few who knew his attainments can appreciate how much palæontological science* would have been advanced *had he been able to publish his observations and conclusions.*" (Italics are mine.) I may mention here, that the statements of Dr. O. Meyer in regard to the Batrachia and Mammals from the Jurassic, and the oldest "bird" *Laopteryx*, are true.

Now let us consider some papers of Prof. Marsh which were doubtless written by himself. There is one on the Cretaceous Mammals. In this paper several times over three or four genera are made out of three or four teeth belonging to animals of one genus. Incisor, molar and premolar teeth of the upper and lower jaw are considered to belong to three or four different animals; each representing a new genus. The discovery of Cretaceous mammals in great numbers (only one species was known before, which was found by Dr. J. L. Wortman, Prof. Cope's former assistant) of course was a very interesting fact, and it is certainly this fact which induced Prof. Flower and Prof. Gaudry to write complimentary letters to Prof. Marsh. But the latter discovery is due entirely to Mr. J. B. Hatcher and Dr. C. E. Beecher. The description given by Prof. Marsh of these fragmentary, but highly interesting, fossils is simply ridiculous, and has been already criticised

by Prof. Cope and Mr. Lydekker, of the British Museum. Among other cases of the kind, I may mention only two, of one of which Dr. O. Meyer has already written. In 1877 Prof. Marsh described a new mammal under the name of *Apatodon mirus*, from the Jurassic of the Rocky Mountains, with the following words: "One of the most interesting specimens hitherto found in the Rocky Mountain region, is a portion of a lower jaw with the last molar in place. This fossil is widely different from anything yet discribed, and its exact affinities are doubtful. The fragment pertained to an animal about as large as a Tapir, and the general appearance of the specimen at once suggests the mammalian type. The tooth most resembles, in form and superior surface of crown, that of a typical suilline. The structure of the tooth, however, is different, and the fangs are, in part at least, coössified with the jaw.

"This specimen was found near a locality where Dinosaur bones were abundant, and it is possible it may belong with that gronp. The jaw, however, is very unlike any corresponding jaw of a Dinosaur, so far as now known. The geological horizon is Lower Cretaceous or Jurassic."

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their close affinity has now been clearly demonstrated." Now a word about this great discovery, which has been already reported in text-books and popular works. The specimen on which the conclusion was based is pathological. The animal when alive had a fracture of the lower part of the metatarsus, but it was happy enough to recover from this accident. The bones coössified, as it generally happens in such cases, at the place where they were broken, but not at any other place. From this pathological specimen Prof. Marsh trumpeted forth to the world one of his greatest discoveries. Prof. Marsh knows very well that this specimen is pathological, but he has never taken back his blunder, notwithstanding that I discussed this matter at different times with him.

4. Another accusation of Prof. Cope against Prof. Marsh is, that he has plagiarized the work of others. This is so well known among scientists that it is hardly necessary to go into this point. But I may give a few examples. Everybody knows that Prof. Huxley's lectures on the evolution of the horse were written long before Prof. Marsh began to work on the subject. That Kowalevsky published two extensive memoirs on the genealogy of the horse in the year before Marsh, is also a fact.

Prof. Marsh states that he never saw Kowalevsky's work before his own was completed and partly published. This may be, but it hardly agrees with the fact that one of Kowalevsky's papers was published in the greatest palæontological journal of to-day, in Prof. V. Zittel's *Palæontographica*, and the other one in the Memoirs of the St. Petersburg Academy. Prof. Marsh's invectives against Kowalevsky, the most able palæontologist of Europe, a man admired by Darwin and Huxley, who took his life in an attack of insanity, are outrageous. It shows that Prof. Marsh is not afraid of any means he can use to defend his reputation.

In the same way Prof. Marsh has tried to plagiarize an important discovery by Dr. T. W. Hulke, of London, a president of the Geological Society of this city. Dr. Hulke published in 1875, in the Proceedings of the Geol. Soc. of London, a paper, with figures, in which he expressed some entirely new ideas on the pelvis of birds and reptiles. Dr. Hulke sent a copy of this paper to Prof. Marsh, who, besides, receives regularly the *Geological Journal*. Three years later Prof. Marsh publishes exactly the same results as Dr. Hulke, and he is kind enough to state in a foot note, "After these figures were made, showing the position of the Dinosaurian pubis, which has caused so much discussion since Cuvier, I found that Dr. T. W. Hulke had already suggested

the true solution of one difficulty (*Journal Geol. Soc. of Lond.*, Vol. XXXII., p. 334)." The year 1875 is wisely left off, and the statement that Dr. Hulke suggested the solution is not true, because he really solved the whole problem in the same manner as Prof. Marsh.

Only a short time ago I had opportunity to observe Prof. Marsh's passion to adorn himself with other's plumes. I have devoted considerable time to the study of the evolution of the skeleton of the ostrich. Among others, I made a discovery which was of especial importance, as it throws new light on the question of the relation between birds and Dinosaurs. I told Prof. Marsh about this discovery, and did not publish it. When Prof. Marsh wrote his paper on *Ornithomimus* he simply claimed the discovery as his own, not mentioning me at all. This I saw when he gave me the proof-sheets of the paper. It was after a discussion of nearly two hours that Prof. Marsh agreed to give me credit for it (in a place where it could be easily overlooked) in the explanation of the figures.

That Prof. Marsh ignores the work of others is a well known fact, which can be seen by everybody who takes the trouble to look over his papers; who will, with extremely rare exceptions, never find any paper cited. There is, it is true, a extensive bibliography appearing as an appendix to the Dinocerata, but this bibliography is not used in the text, and nobody can see from the text what has been done by others on this order.

5. Dr. O. Meyer has made the statement that specimens are restored in a very unscientific way under the direction of Prof. Marsh. This statement I sustain. Plaster of Paris has been used in restorations in a very extensive way, although latterly, I am glad to say, there has been a reduction of the extent of it. I have seen specimens restored with colored plaster, so that it was hard to tell where the bone began and the plaster ended. Such specimens are made nearly useless for exact study, and it will only be possible after the plaster has been removed, and this with great difficulty. Colored plaster has been used especially in restoring bones of Sauropoda, Stegosauridæ, and Dinocerata. The general effect is that nearly all the specimens of this group look complete. But this artificial embellishment of the specimens has also been transferred to the drawings. Some of the plates of the great volumes which wait for publication contain drawings of complete bones, but which, if examined, consist of a considerable part of plaster. That such plates are unscientific, I do not need to state. I must say, in justice to Prof. Marsh, that for the last five years this method has been stopped, and that now, with very few exceptions, the drawings are

made from the actual specimens, and that the missing parts are shaded in. A very great calamity is, that the specimens are often not drawn as they really appear in nature, but that they are drawn restored. These restorations are made according to the order of the Professor. If it now happens that the restoration should prove to be incorrect, the plate becomes worthless and has no scientific value.

Dr. O. Meyer has stated that Prof. Marsh has antedated his volume on the Dinocerata intentionally. This is also true; and everything that has been said by him about this point is correct. The review of this work was written by Prof. Marsh himself, and he asked the signatures of Mr. Harger and Dr. Williston for it without success, and had to accept instead the initials of the lady type-writer.

7. There is one insinuation made in the article of Dr. Meyer on which I have to say a few words. It refers, if I understand rightly, to the type specimen of *Triglyphus* which has disappeared from the Museum at Stuttgart. Dr. Meyer has asked Prof. Marsh to state how he came in to possession of a tooth from a "Jurassic" (Triassic) mammal from Germany, of which Prof. Marsh told Dr. Meyer. Prof. Marsh has not answered Dr. Meyer's article. In justice to Prof. Marsh, I state that the tooth in the possession of Prof. O. C. Marsh was purchased from a dealer of Stuttgart, in 1865, *and that it is not the type of Triglyphus which disappeared from the Stuttgart Museum.* All the positive statements of Dr. Meyer's article I consider to be true.

8. Prof. Cope thinks "that an investigation as to who has delivered Prof. Marsh's lectures in Yale College during past years will yield some interesting results." To this I have to say, that such an investigation is not necessary; *Prof. Marsh does not lecture at Yale at all.*

9. Prof. W. B. Scott, of Princeton, has published in the *Herald* of January 22d, a letter written by him to Prof. Marsh. What Prof. Scott has said there I fully sustain. He says: "I feel constrained to say that I disapprove of your work, your methods and your administration of the office which you hold. This disapproval does not rest on what I have heard from others, nor upon any personal considerations, but upon my own experience and my studies in the field to which both you and I are devoted. If called upon to testify in any investigation, this is the line to which, however reluctantly, I shall be compelled to adhere."

G. Baur, Ph.D.